

## INTRODUCTION

Each chapter of the 2010 edition of the U.S. Geological Survey (USGS) Mineral Commodity Summaries (MCS) includes information on events, trends, and issues for each mineral commodity as well as discussions and tabular presentations on domestic industry structure, Government programs, tariffs, 5-year salient statistics, and world production and resources. The MCS is the earliest comprehensive source of 2009 mineral production data for the world. More than 90 individual minerals and materials are covered by two-page synopses.

For mineral commodities for which there is a Government stockpile, detailed information concerning the stockpile status is included in the two-page synopsis.

National reserves information for most mineral commodities found in this report, including those for the United States, are derived from a variety of sources. The ideal source of such information would be comprehensive evaluations that apply the same criteria to deposits in different geographic areas and report the results by country. In the absence of such evaluations, national reserves estimates compiled by countries for selected mineral commodities are a primary source of national reserves information. Lacking national assessment information by governments, sources such as academic articles, company reports, presentations by company representatives, and trade journal articles, or a combination of these, serve as the basis for national reserves information reported in the mineral commodity sections of this publication.

A national estimate may be assembled from the following: historically reported reserves information carried for years without alteration because no new information is available; historically reported reserves reduced by the amount of historical production; and company reported reserves. International minerals availability studies conducted by the U.S. Bureau of Mines (USBM), before 1996, and estimates of identified resources by an international collaborative effort (the International Strategic Minerals Inventory) are the basis for some reserves estimates. The USGS collects information about the quantity and quality of mineral resources but does not directly measure reserves, and companies or governments do not directly report reserves to the USGS. Reassessment of reserves is a continuing process, and the intensity of this process differs for mineral commodities, countries, and time period.

Throughout the history of Mineral Commodity Summaries and its predecessor prior to 1978, Commodity Data Summaries, the presentation of resource data has evolved. Although world resources have been discussed each year, presentation of reserves and reserve base data varied. From 1957 through 1979, only reserves information was published in the reports, but from 1980 through 1987, only estimates of reserve base, a concept introduced by the U.S. Bureau of Mines (USBM) and the USGS in 1980, were published. Beginning in 1988, both reserves and reserve base information were listed for each mineral commodity where applicable and available. Prior to 1996, the minerals availability studies conducted by the USBM and work with international collaborators were the basis for reserve base data reported in Mineral Commodity Summaries. When the USBM was closed in 1996, this function was discontinued. Since that time, reserve base estimates have been updated to be consistent with changes in reserves, but the nonreserves component of the information upon which the reserve base data were estimated is not current enough to support defensible reserve base estimates. For that reason, publication of reserve base estimates was discontinued for Mineral Commodity Summaries 2010.

Abbreviations and units of measure, and definitions of selected terms used in the report, are in Appendix A and Appendix B, respectively. A resource/reserve classification for minerals, based on USGS Circular 831 (published with the U.S. Bureau of Mines) is Appendix C, and a directory of USGS minerals information country specialists and their responsibilities is Appendix D.

The USGS continually strives to improve the value of its publications to users. Constructive comments and suggestions by readers of the MCS 2010 are welcomed.

## APPENDIX A

### Abbreviations and Units of Measure

1 carat (metric) (diamond)	= 200 milligrams
1 flask (fl)	= 76 pounds, avoirdupois
1 karat (gold)	= one twenty-fourth part
1 kilogram (kg)	= 2.2046 pounds, avoirdupois
1 long ton (lt)	= 2,240 pounds, avoirdupois
1 long ton unit (ltu)	= 1% of 1 long ton or 22.4 pounds avoirdupois
long calcined ton (lct)	= excludes water of hydration
long dry ton (ldt)	= excludes excess free moisture
Mcf	= 1,000 cubic feet
1 metric ton (t)	= 2,204.6 pounds, avoirdupois or 1,000 kilograms
1 metric ton (t)	= 1.1023 short ton
1 metric ton unit (mtu)	= 1% of 1 metric ton or 10 kilograms
1 pound (lb)	= 453.6 grams
1 short ton (st)	= 2,000 pounds, avoirdupois
1 short ton unit (stu)	= 1% of 1 short ton or 20 pounds, avoirdupois
1 short dry ton (sdt)	= 2,000 pounds, avoirdupois, excluding moisture content
1 troy ounce (tr oz)	= 1.09714 avoirdupois ounces or 31.103 grams
1 troy pound	= 12 troy ounces

## APPENDIX B

### Definitions of Selected Terms Used in This Report

#### Terms Used for Materials in the National Defense Stockpile and Helium Stockpile

**Uncommitted inventory** refers to the quantity of mineral materials held in the National Defense Stockpile. Nonstockpile-grade materials may be included in the table; where significant, the quantities of these stockpiled materials will be specified in the text accompanying the table.

**Authorized for disposal** refers to quantities that are in excess of the stockpile goal for a material, and for which Congress has authorized disposal over the long term at rates designed to maximize revenue but avoid undue disruption of the usual markets and financial loss to the United States.

**Disposal plan FY 2009** indicates the total amount of a material in the National Defense Stockpile that the U.S. Department of Defense is permitted to sell under the Annual Materials Plan approved by Congress for the fiscal year. FY 2009 (fiscal year 2009) is the period October 1, 2008, through September 30, 2009. For mineral commodities that have a disposal plan greater than the inventory, actual quantity will be limited to remaining disposal authority or inventory. Note that, unlike the National Defense Stockpile, helium stockpile sales by the Bureau of Land Management under the Helium Privatization Act of 1996 are permitted to exceed disposal plans.

**Disposals FY 2009** refers to material sold or traded from the stockpile in FY 2009.

#### Depletion Allowance

The depletion allowance is a business tax deduction analogous to depreciation, but applies to an ore reserve rather than equipment or production facilities. Federal tax law allows this deduction from taxable corporate income, recognizing that an ore deposit is a depletable asset that must eventually be replaced.

## APPENDIX C

### A Resource/Reserve Classification for Minerals<sup>1</sup>

#### INTRODUCTION

Through the years, geologists, mining engineers, and others operating in the minerals field have used various terms to describe and classify mineral resources, which as defined herein include energy materials. Some of these terms have gained wide use and acceptance, although they are not always used with precisely the same meaning.

The U.S. Geological Survey (USGS) collects information about the quantity and quality of all mineral resources. In 1976, the USGS and the U.S. Bureau of Mines developed a common classification and nomenclature, which was published as USGS Bulletin 1450-A—*“Principles of the Mineral Resource Classification System of the U.S. Bureau of Mines and U.S. Geological Survey.”* Experience with this resource classification system showed that some changes were necessary in order to make it more workable in practice and more useful in long-term planning. Therefore, representatives of the USGS and the U.S. Bureau of Mines collaborated to revise Bulletin 1450-A. Their work was published in 1980 as USGS Circular 831—*“Principles of a Resource/Reserve Classification for Minerals.”*

Long-term public and commercial planning must be based on the probability of discovering new deposits, on developing economic extraction processes for currently unworkable deposits, and on knowing which resources are immediately available. Thus, resources must be continuously reassessed in the light of new geologic knowledge, of progress in science and technology, and of shifts in economic and political conditions. To best serve these planning needs, known resources should be classified from two standpoints: (1) purely geologic or physical/chemical characteristics—such as grade, quality, tonnage, thickness, and depth—of the material in place; and (2) profitability analyses based on costs of extracting and marketing the material in a given economy at a given time. The former constitutes important objective scientific information of the resource and a relatively unchanging foundation upon which the latter more valuable economic delineation can be based.

The revised classification system, designed generally for all mineral materials, is shown graphically in figures 1 and 2; its components and their usage are described in the text. The classification of mineral and energy resources is necessarily arbitrary, because definitional criteria do not always coincide with natural boundaries. The system can be used to report the status of mineral and energy-fuel resources for the Nation or for specific areas.

#### RESOURCE/RESERVE DEFINITIONS

A dictionary definition of resource, “something in reserve or ready if needed,” has been adapted for mineral and energy resources to comprise all materials,

including those only surmised to exist, that have present or anticipated future value.

**Resource.**—A concentration of naturally occurring solid, liquid, or gaseous material in or on the Earth’s crust in such form and amount that economic extraction of a commodity from the concentration is currently or potentially feasible.

**Original Resource.**—The amount of a resource before production.

**Identified Resources.**—Resources whose location, grade, quality, and quantity are known or estimated from specific geologic evidence. Identified resources include economic, marginally economic, and sub-economic components. To reflect varying degrees of geologic certainty, these economic divisions can be subdivided into measured, indicated, and inferred.

**Demonstrated.**—A term for the sum of measured plus indicated.

**Measured.**—Quantity is computed from dimensions revealed in outcrops, trenches, workings, or drill holes; grade and(or) quality are computed from the results of detailed sampling. The sites for inspection, sampling, and measurements are spaced so closely and the geologic character is so well defined that size, shape, depth, and mineral content of the resource are well established.

**Indicated.**—Quantity and grade and(or) quality are computed from information similar to that used for measured resources, but the sites for inspection, sampling, and measurement are farther apart or are otherwise less adequately spaced. The degree of assurance, although lower than that for measured resources, is high enough to assume continuity between points of observation.

**Inferred.**—Estimates are based on an assumed continuity beyond measured and(or) indicated resources, for which there is geologic evidence. Inferred resources may or may not be supported by samples or measurements.

**Reserve Base.**—That part of an identified resource that meets specified minimum physical and chemical criteria related to current mining and production practices, including those for grade, quality, thickness, and depth. The reserve base is the in-place demonstrated (measured plus indicated) resource from which reserves are estimated. It may encompass those parts of the resources that have a reasonable potential for becoming economically available within planning horizons beyond those that assume proven technology and current economics. The reserve base includes those resources that are currently economic (reserves), marginally economic (marginal reserves), and some of those that are currently subeconomic (subeconomic resources). The term “geologic reserve” has been applied by others generally to the reserve-base category, but it also may include the inferred-reserve-base category; it is not a part of this classification system.

<sup>1</sup>Based on U.S. Geological Survey Circular 831, 1980.

**Inferred Reserve Base.**—The in-place part of an identified resource from which inferred reserves are estimated. Quantitative estimates are based largely on knowledge of the geologic character of a deposit and for which there may be no samples or measurements. The estimates are based on an assumed continuity beyond the reserve base, for which there is geologic evidence.

**Reserves.**—That part of the reserve base which could be economically extracted or produced at the time of determination. The term reserves need not signify that extraction facilities are in place and operative. Reserves include only recoverable materials; thus, terms such as “extractable reserves” and “recoverable reserves” are redundant and are not a part of this classification system.

**Marginal Reserves.**—That part of the reserve base which, at the time of determination, borders on being economically producible. Its essential characteristic is economic uncertainty. Included are resources that would be producible, given postulated changes in economic or technological factors.

**Economic.**—This term implies that profitable extraction or production under defined investment assumptions has been established, analytically demonstrated, or assumed with reasonable certainty.

**Subeconomic Resources.**—The part of identified resources that does not meet the economic criteria of reserves and marginal reserves.

**Undiscovered Resources.**—Resources, the existence of which are only postulated, comprising deposits that are separate from identified resources. Undiscovered resources may be postulated in deposits of such grade and physical location as to render them economic, marginally economic, or subeconomic. To reflect varying degrees of geologic certainty, undiscovered resources may be divided into two parts:

**Hypothetical Resources.**—Undiscovered resources that are similar to known mineral bodies and that may be reasonably expected to exist in the same producing district or region under analogous geologic conditions. If exploration confirms their existence and reveals enough information about

their quality, grade, and quantity, they will be reclassified as identified resources.

**Speculative Resources.**—Undiscovered resources that may occur either in known types of deposits in favorable geologic settings where mineral discoveries have not been made, or in types of deposits as yet unrecognized for their economic potential. If exploration confirms their existence and reveals enough information about their quantity, grade, and quality, they will be reclassified as identified resources.

**Restricted Resources/Reserves.**—That part of any resource/reserve category that is restricted from extraction by laws or regulations. For example, restricted reserves meet all the requirements of reserves except that they are restricted from extraction by laws or regulations.

**Other Occurrences.**—Materials that are too low grade or for other reasons are not considered potentially economic, in the same sense as the defined resource, may be recognized and their magnitude estimated, but they are not classified as resources. A separate category, labeled other occurrences, is included in figures 1 and 2. In figure 1, the boundary between subeconomic and other occurrences is limited by the concept of current or potential feasibility of economic production, which is required by the definition of a resource. The boundary is obviously uncertain, but limits may be specified in terms of grade, quality, thickness, depth, percent extractable, or other economic-feasibility variables.

**Cumulative Production.**—The amount of past cumulative production is not, by definition, a part of the resource. Nevertheless, a knowledge of what has been produced is important in order to understand current resources, in terms of both the amount of past production and the amount of residual or remaining in-place resource. A separate space for cumulative production is shown in figures 1 and 2. Residual material left in the ground during current or future extraction should be recorded in the resource category appropriate to its economic-recovery potential.

**FIGURE 1.—Major Elements of Mineral-Resource Classification, Excluding *Reserve Base* and *Inferred Reserve Base***

Cumulative Production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range	
	Measured	Indicated		Hypothetical	(or) Speculative
ECONOMIC	Reserves		Inferred Reserves	+	
MARGINALLY ECONOMIC	Marginal Reserves		Inferred Marginal Reserves		
SUBECONOMIC	Demonstrated Subeconomic Resources		Inferred Subeconomic Resources		
Other Occurrences	Includes nonconventional and low-grade materials				

**FIGURE 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories**

Cumulative Production	IDENTIFIED RESOURCES			UNDISCOVERED RESOURCES	
	Demonstrated		Inferred	Probability Range	
	Measured	Indicated		Hypothetical	(or) Speculative
ECONOMIC	Reserve		Inferred	+	
MARGINALLY ECONOMIC	Base		Reserve		
SUBECONOMIC	Base		Base		
Other Occurrences	Includes nonconventional and low-grade materials				

**APPENDIX D****Country Specialists Directory**

Minerals information country specialists at the U.S. Geological Survey collect and analyze information on the mineral industries of more than 170 nations throughout the world. The specialists are available to answer minerals-related questions concerning individual countries.

**Africa and the Middle East**

Algeria Mowafa Taib  
 Angola Omayra Bermúdez-Lugo  
 Bahrain Mowafa Taib  
 Benin Omayra Bermúdez-Lugo  
 Botswana Harold R. Newman  
 Burkina Faso Omayra Bermúdez-Lugo  
 Burundi Thomas R. Yager  
 Cameroon Harold R. Newman  
 Cape Verde Harold R. Newman  
 Central African Republic Omayra Bermúdez-Lugo  
 Chad Philip M. Mobbs  
 Comoros Harold R. Newman  
 Congo (Brazzaville) Philip M. Mobbs  
 Congo (Kinshasa) Thomas R. Yager  
 Côte d'Ivoire Omayra Bermúdez-Lugo  
 Djibouti Thomas R. Yager  
 Egypt Mowafa Taib  
 Equatorial Guinea Philip M. Mobbs  
 Eritrea Harold R. Newman  
 Ethiopia Thomas R. Yager  
 Gabon Omayra Bermúdez-Lugo  
 The Gambia Omayra Bermúdez-Lugo  
 Ghana Omayra Bermúdez-Lugo  
 Guinea Omayra Bermúdez-Lugo  
 Guinea-Bissau Omayra Bermúdez-Lugo  
 Iran Philip M. Mobbs  
 Iraq Mowafa Taib  
 Israel Thomas R. Yager  
 Jordan Mowafa Taib  
 Kenya Thomas R. Yager  
 Kuwait Philip M. Mobbs  
 Lebanon Mowafa Taib  
 Lesotho Harold R. Newman  
 Liberia Omayra Bermúdez-Lugo  
 Libya Mowafa Taib  
 Madagascar Thomas R. Yager  
 Malawi Thomas R. Yager  
 Mali Omayra Bermúdez-Lugo  
 Mauritania Mowafa Taib  
 Mauritius Harold R. Newman  
 Morocco & Western Sahara Harold R. Newman  
 Mozambique Thomas R. Yager  
 Namibia Omayra Bermúdez-Lugo  
 Niger Omayra Bermúdez-Lugo  
 Nigeria Philip M. Mobbs  
 Oman Mowafa Taib  
 Qatar Mowafa Taib  
 Reunion Harold R. Newman  
 Rwanda Thomas R. Yager  
 São Tomé & Príncipe Omayra Bermúdez-Lugo  
 Saudi Arabia Philip M. Mobbs  
 Senegal Omayra Bermúdez-Lugo  
 Seychelles Harold R. Newman  
 Sierra Leone Omayra Bermúdez-Lugo  
 Somalia Thomas R. Yager

South Africa  
 Sudan  
 Swaziland  
 Syria  
 Tanzania  
 Togo  
 Tunisia  
 Turkey  
 Uganda  
 United Arab Emirates  
 Yemen  
 Zambia  
 Zimbabwe

Thomas R. Yager  
 Thomas R. Yager  
 Harold R. Newman  
 Mowafa Taib  
 Thomas R. Yager  
 Omayra Bermúdez-Lugo  
 Mowafa Taib  
 Philip M. Mobbs  
 Harold R. Newman  
 Mowafa Taib  
 Mowafa Taib  
 Philip M. Mobbs  
 Philip M. Mobbs

**Asia and the Pacific**

Afghanistan  
 Australia  
 Bangladesh  
 Bhutan  
 Brunei  
 Burma  
 Cambodia  
 China  
 Fiji  
 India  
 Indonesia  
 Japan  
 Korea, North  
 Korea, Republic of  
 Laos  
 Malaysia  
 Mongolia  
 Nauru  
 Nepal  
 New Caledonia  
 New Zealand  
 Pakistan  
 Papua New Guinea  
 Philippines  
 Singapore  
 Solomon Islands  
 Sri Lanka  
 Taiwan  
 Thailand  
 Timor, East  
 Tonga  
 Vanuatu  
 Vietnam

Chin S. Kuo  
 Pui-Kwan Tse  
 Yolanda Fong-Sam  
 Lin Shi  
 Pui-Kwan Tse  
 Yolanda Fong-Sam  
 Yolanda Fong-Sam  
 Pui-Kwan Tse  
 Lin Shi  
 Chin S. Kuo  
 Chin S. Kuo  
 Chin S. Kuo  
 Lin Shi  
 Lin Shi  
 Yolanda Fong-Sam  
 Pui-Kwan Tse  
 Susan G. Wacaster  
 Pui-Kwan Tse  
 Lin Shi  
 Susan G. Wacaster  
 Pui-Kwan Tse  
 Chin S. Kuo  
 Susan G. Wacaster  
 Yolanda Fong-Sam  
 Pui-Kwan Tse  
 Chin S. Kuo  
 Chin S. Kuo  
 Pui-Kwan Tse  
 Lin Shi  
 Pui-Kwan Tse  
 Chin S. Kuo  
 Chin S. Kuo  
 Yolanda Fong-Sam

**Europe and Central Eurasia**

Albania  
 Armenia<sup>1</sup>  
 Austria<sup>2</sup>  
 Azerbaijan<sup>1</sup>  
 Belarus<sup>1</sup>

Mark Brininstool  
 Richard M. Levine  
 Steven T. Anderson  
 Richard M. Levine  
 Richard M. Levine

**Europe and Central Eurasia—continued**

Belgium <sup>2</sup>	Alberto A. Perez
Bosnia and Herzegovina	Mark Brininstool
Bulgaria <sup>2</sup>	Mark Brininstool
Croatia	Mark Brininstool
Cyprus <sup>2</sup>	Harold R. Newman
Czech Republic <sup>2</sup>	Mark Brininstool
Denmark, Faroe Islands, and Greenland <sup>2</sup>	Harold R. Newman
Estonia <sup>2</sup>	Richard M. Levine
Finland <sup>2</sup>	Harold R. Newman
France <sup>2</sup>	Alberto A. Perez
Georgia <sup>1</sup>	Richard M. Levine
Germany <sup>2</sup>	Steven T. Anderson
Greece <sup>2</sup>	Harold R. Newman
Hungary <sup>2</sup>	Richard M. Levine
Iceland	Harold R. Newman
Ireland <sup>2</sup>	Harold R. Newman
Italy <sup>2</sup>	Alberto A. Perez
Kazakhstan <sup>1</sup>	Richard M. Levine
Kyrgyzstan <sup>1</sup>	Richard M. Levine
Latvia <sup>2</sup>	Richard M. Levine
Lithuania <sup>2</sup>	Richard M. Levine
Luxembourg <sup>2</sup>	Alberto A. Perez
Macedonia	Mark Brininstool
Malta <sup>2</sup>	Harold R. Newman
Moldova <sup>1</sup>	Richard M. Levine
Montenegro	Mark Brininstool
Netherlands <sup>2</sup>	Alberto A. Perez
Norway	Harold R. Newman
Poland <sup>2</sup>	Mark Brininstool
Portugal <sup>2</sup>	Alfredo C. Gurmendi
Romania <sup>2</sup>	Mark Brininstool
Russia <sup>1</sup>	Richard M. Levine
Serbia	Mark Brininstool
Slovakia <sup>2</sup>	Mark Brininstool
Slovenia <sup>2</sup>	Mark Brininstool
Spain <sup>2</sup>	Alfredo C. Gurmendi
Sweden <sup>2</sup>	Harold R. Newman
Switzerland	Harold R. Newman
Tajikistan <sup>1</sup>	Richard M. Levine

Turkmenistan<sup>1</sup>  
Ukraine<sup>1</sup>  
United Kingdom<sup>2</sup>  
Uzbekistan<sup>1</sup>

Richard M. Levine  
Richard M. Levine  
Alberto A. Perez  
Richard M. Levine

**North America, Central America, and the Caribbean**

Belize	Susan G. Wacaster
Canada	Philip M. Mobbs
Costa Rica	Susan G. Wacaster
Cuba	Omayra Bermúdez-Lugo
Dominican Republic	Susan G. Wacaster
El Salvador	Susan G. Wacaster
Guatemala	Steven T. Anderson
Haiti	Susan G. Wacaster
Honduras	Susan G. Wacaster
Jamaica	Susan G. Wacaster
Mexico	Alberto A. Perez
Nicaragua	Susan G. Wacaster
Panama	Susan G. Wacaster
Trinidad and Tobago	Susan G. Wacaster

**South America**

Argentina	Steven T. Anderson
Bolivia	Steven T. Anderson
Brazil	Alfredo C. Gurmendi
Chile	Steven T. Anderson
Colombia	Susan G. Wacaster
Ecuador	Susan G. Wacaster
French Guiana	Alfredo C. Gurmendi
Guyana	Alfredo C. Gurmendi
Paraguay	Alfredo C. Gurmendi
Peru	Alfredo C. Gurmendi
Suriname	Alfredo C. Gurmendi
Uruguay	Alfredo C. Gurmendi
Venezuela	Alfredo C. Gurmendi

<sup>1</sup>Member of Commonwealth of Independent States.

<sup>2</sup>Member of European Union.

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