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
metric dry ton (mdt)	= excludes excess free moisture
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
short dry ton (sdt)	= excludes excess free moisture
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

Inventory refers to the quantity of mineral materials held in the National Defense Stockpile or in the Federal Helium Reserve. Nonstockpile-grade materials may be included in the table; where significant, the quantities of these stockpiled materials are specified in the text accompanying the table.

Potential disposals indicate the total amount of a material in the National Defense Stockpile that the U.S. Department of Defense is permitted to dispose of under the Annual Materials Plan approved by Congress for the fiscal year. Congress has authorized disposal over the long term at rates designed to maximize revenue but avoid undue disruption to the usual markets and financial loss to the United States. Fiscal year (FY) 2019 is the period from October 1, 2018, through September 30, 2019. FY 2020 is the period from October 1, 2019, through September 30, 2020. Disposals are defined as any disposal or sale of National Defense Stockpile stock. For mineral commodities that have a disposal plan greater than the inventory, the actual quantity will be limited to the remaining disposal authority or inventory. Unlike sales from the National Defense Stockpile, helium sales by the Bureau of Land Management under the Helium Privatization Act of 1996 are permitted to exceed disposal plans.

Potential acquisitions indicate the maximum amount of a material that may be acquired by the U.S. Department of Defense for the National Defense Stockpile under the Annual Materials Plan approved by Congress for the fiscal year. FY 2019 is the period from October 1, 2018, through September 30, 2019. FY 2020 is the period from October 1, 2019, through September 30, 2020.

Depletion Allowance

The depletion allowance is a business tax deduction analogous to depreciation, but which 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—Reserves and Resources

Reserves data are dynamic. They may be reduced as ore is mined and (or) the feasibility of extraction diminishes, or more commonly, they may continue to increase as additional deposits (known or recently discovered) are developed, or currently exploited deposits are more thoroughly explored and (or) new technology or economic variables improve their economic feasibility. Reserves may be considered a working inventory of mining companies' supplies of an economically extractable mineral commodity. As such, the magnitude of that inventory is necessarily limited by many considerations, including cost of drilling, taxes, price of the mineral commodity being mined, and the demand for it. Reserves will be developed to the point of business needs and geologic limitations of economic ore grade and tonnage. For example, in 1970, identified and undiscovered world copper resources were estimated to contain 1.6 billion metric tons of copper, with reserves of about 280 million tons of copper. Since then, almost 560 million tons of copper have been produced worldwide, but world copper reserves in 2019 were estimated to be 870 million tons of copper, more than triple those of 1970, despite the depletion by mining of more than the original estimated reserves.

Future supplies of minerals will come from reserves and other identified resources, currently undiscovered resources in deposits that will be discovered in the future, and material that will be recycled from current in-use stocks of minerals or from minerals in waste disposal sites. Undiscovered deposits of minerals constitute an important consideration in assessing future supplies. Mineral-resource assessments have been carried out for small parcels of land being evaluated for land reclassification, for the Nation, and for the world.

Part A—Resource/Reserve Classification for Minerals[1]

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 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.[1]

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 subeconomic components. To reflect varying degrees of geologic certainty, these economic divisions can be subdivided into measured, indicated, and inferred.

[1]Based on U.S. Geological Survey Circular 831, 1980.

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.

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, as follows:

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*

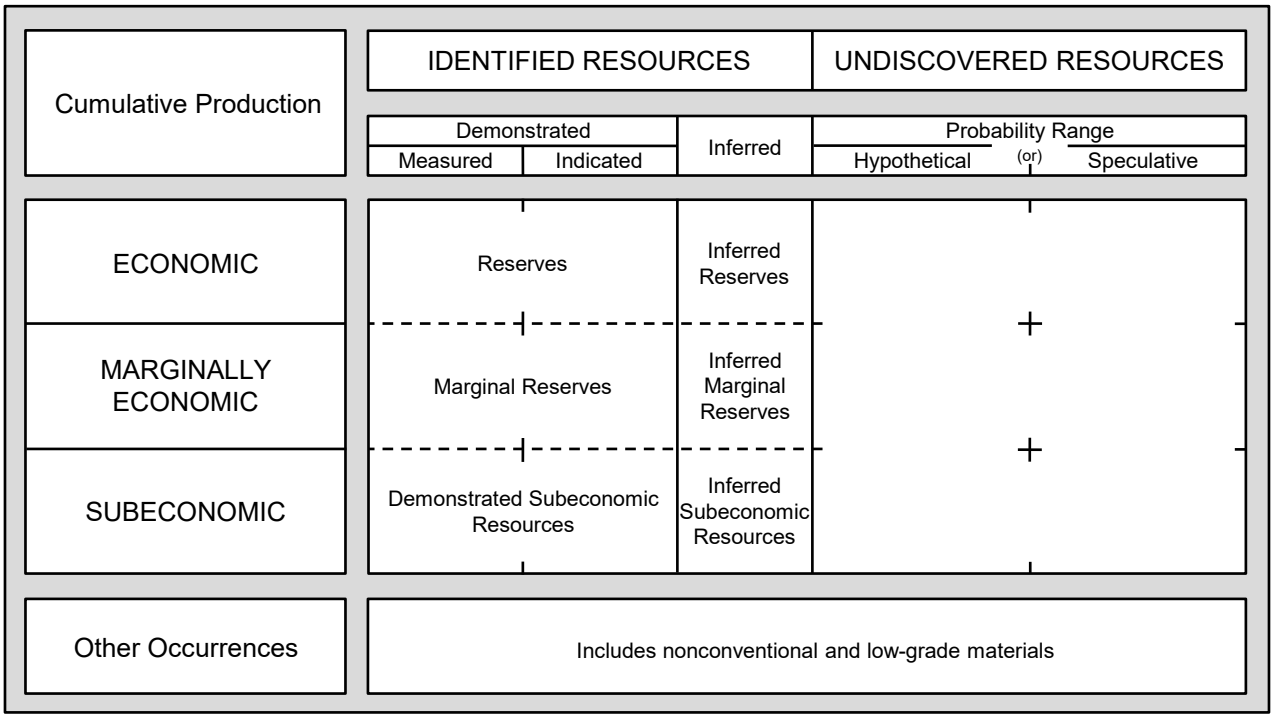
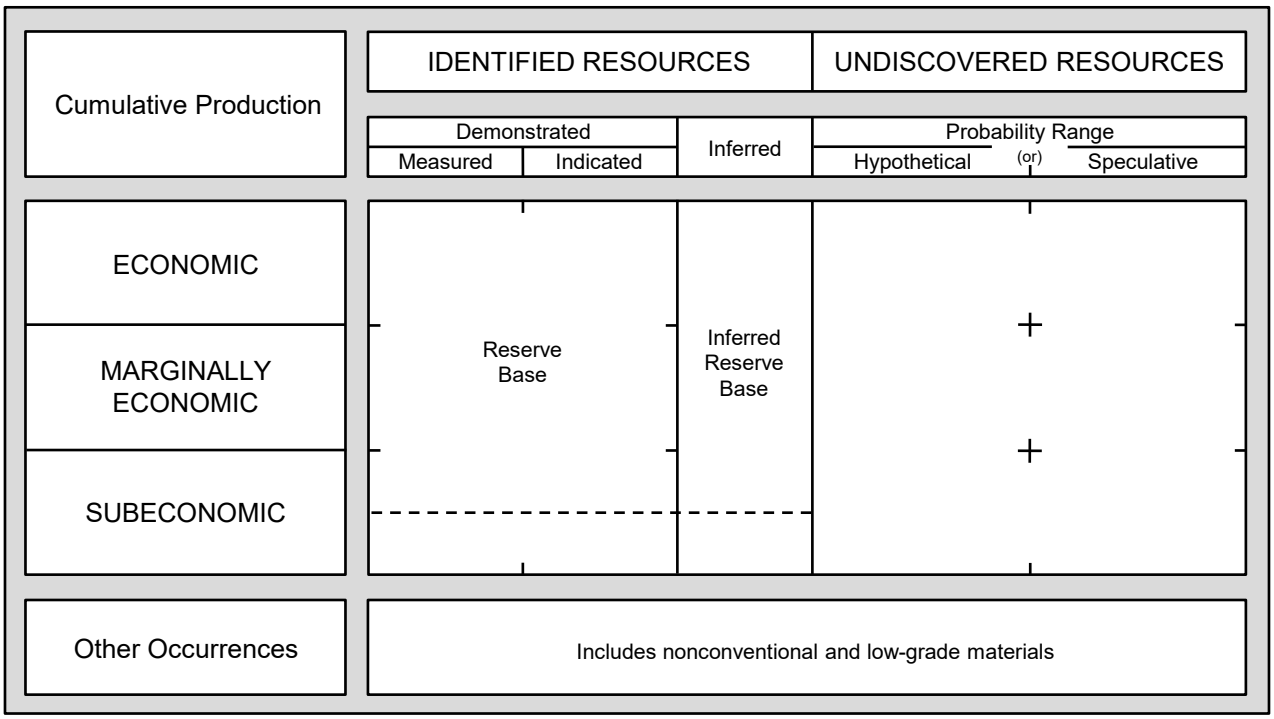


Figure 2.—*Reserve Base* and *Inferred Reserve Base* Classification Categories



Part B—Sources of Reserves Data

National information on reserves for most mineral commodities found in this report, including those for the United States, is 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 information on reserves 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 before 1996 and estimates of identified resources by an international collaborative effort (the International Strategic Minerals Inventory) are the bases 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.

Some countries have specific definitions for reserves data, and reserves for each country are assessed separately, based on reported data and definitions. An attempt is made to make reserves consistent among countries for a mineral commodity and its byproducts. For example, the Australasian Joint Ore Reserves Committee (JORC) established the Australasian Code for Reporting of Exploration Results, Mineral Resources and Ore Reserves (the JORC Code) that sets out minimum standards, recommendations, and guidelines for public reporting in Australasia of exploration results, mineral resources, and ore reserves. Companies listed on the Australian Securities Exchange and the New Zealand Stock Exchange are required to report publicly on ore reserves and mineral resources under their control, using the JORC Code.

Data reported for individual deposits by mining companies are compiled in Geoscience Australia's national mineral resources database and used in the preparation of the annual national assessments of Australia's mineral resources. Because of its specific use in the JORC Code, the term "reserves" is not used in the national inventory, where the highest category is "Economic Demonstrated Resources" (EDR). In essence, EDR combines the JORC Code categories proved reserves and probable reserves, plus measured resources and indicated resources. This is considered to provide a reasonable and objective estimate of what is likely to be available for mining in the long term. Accessible Economic Demonstrated Resources represent the resources within the EDR category that are accessible for mining. Reserves for Australia in Mineral Commodity Summaries 2020 are Accessible EDR. For more information, see table 3. Australia's Identified Mineral Resources as of December 2017 can be found at https://d28rz98at9flks.cloudfront.net/124309/124309_AIMR.pdf.

In Canada, the Canadian Institute of Mining, Metallurgy and Petroleum (CIM) provides definition standards for the classification of mineral resources and mineral reserves estimates into various categories. The category to which a resource or reserves estimate is assigned depends on the level of confidence in the geologic information available on the mineral deposit, the quality and quantity of data available on the deposit, the level of detail of the technical and economic information that has been generated about the deposit, and the interpretation of the data and information. For more information on the CIM definition standards, see https://mrmr.cim.org/en/standards/canadian-mineral-resource-and-mineral-reserve-definitions/.

In Russia, reserves for most minerals can appear in a number of sources, although no comprehensive list of reserves is published. Reserves data for a limited set of mineral commodities are available in the annual report "Gosudarstvennyi Doklad o Sostoyanii i Ispol'zovanii Mineral'no-Syryevyh Resursov Rossiyskoy Federatsii" (State report on the state and use of mineral and raw materials resources of the Russian Federation), which is published by the Ministry of Natural Resources and Environment of the Russian Federation. Reserves data for various minerals appear at times in journal articles, such as those in the journal "Mineral'nyye Resursy Rossii. Ekonomika i Upravleniye" (Mineral Resources of Russia. Economics and Management), which is published by the "OOO RG-Inform," a subsidiary of Rosgeologiya Holding. It is sometimes not clear if the reserves are being reported in ore or mineral content. It is also in many cases not clear which definition of reserves is being used, because the system inherited from the former Soviet Union has a number of ways in which the term "reserves" is defined, and these definitions qualify the percentage of reources that are included in a specific category. For example, the Soviet reserves classification system, besides the categories A, B, C1, and C2, which represent progressively detailed knowledge of a mineral deposit based on exploration data, has other subcategories cross imposed upon the system. Under the broad category reserves (zapasy), there are subcategories that include balance reserves (economic reserves or balansovyye zapasy) and outside-the-balance reserves (non-economic reserves or zabalansovye zapasy), as well as categories that include explored, industrial, and proven reserves, and the reserves totals can vary significantly, depending on the specific definition of reserves being reported.

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	Meralis Plaza-Toledo
Bahrain	Philip A. Szczesniak
Benin	Meralis Plaza-Toledo
Botswana	Thomas R. Yager
Burkina Faso	Alberto A. Perez
Burundi	Thomas R. Yager
Cabo Verde	Meralis Plaza-Toledo
Cameroon	Philip A. Szczesniak
Central African Republic	James J. Barry
Chad	Philip A. Szczesniak
Comoros	James J. Barry
Congo (Brazzaville)	James J. Barry
Congo (Kinshasa)	Thomas R. Yager
Côte d'Ivoire	Alberto A. Perez
Djibouti	Thomas R. Yager
Egypt	Mowafa Taib
Equatorial Guinea	Meralis Plaza-Toledo
Eritrea	Thomas R. Yager
Eswatini	James J. Barry
Ethiopia	Meralis Plaza-Toledo
Gabon	Alberto A. Perez
The Gambia	Meralis Plaza-Toledo
Ghana	Meralis Plaza-Toledo
Guinea	Alberto A. Perez
Guinea-Bissau	Meralis Plaza-Toledo
Iran	Philip A. Szczesniak
Iraq	Philip A. Szczesniak
Israel	Philip A. Szczesniak
Jordan	Mowafa Taib
Kenya	Thomas R. Yager
Kuwait	Philip A. Szczesniak
Lebanon	Mowafa Taib
Lesotho	James J. Barry
Liberia	Meralis Plaza-Toledo
Libya	Mowafa Taib
Madagascar	Thomas R. Yager
Malawi	Thomas R. Yager
Mali	Alberto A. Perez
Mauritania	Mowafa Taib
Mauritius	James J. Barry
Morocco & Western Sahara	Mowafa Taib
Mozambique	Meralis Plaza-Toledo
Namibia	James J. Barry
Niger	Alberto A. Perez
Nigeria	Thomas R. Yager
Oman	Philip A. Szczesniak
Qatar	Philip A. Szczesniak
Reunion	James J. Barry
Rwanda	Thomas R. Yager
São Tomé & Principe	Meralis Plaza-Toledo
Saudi Arabia	Mowafa Taib
Senegal	Alberto A. Perez
Seychelles	James J. Barry
Sierra Leone	Alberto A. Perez
Somalia	Philip A. Szczesniak
South Africa	Thomas R. Yager
South Sudan	Alberto A. Perez
Sudan	Mowafa Taib
Syria	Mowafa Taib
Tanzania	Thomas R. Yager
Togo	Alberto A. Perez
Tunisia	Mowafa Taib
Uganda	Thomas R. Yager
United Arab Emirates	Philip A. Szczesniak
Yemen	Mowafa Taib
Zambia	James J. Barry
Zimbabwe	James J. Barry

Asia and the Pacific

Afghanistan	Karine M. Renaud
Australia	Spencer D. Buteyn
Bangladesh	Ji Won Moon
Bhutan	Ji Won Moon
Brunei	Spencer D. Buteyn
Burma (Myanmar)	Ji Won Moon
Cambodia	Ji Won Moon
China	Sean Xun
Fiji	Spencer D. Buteyn
India	Karine M. Renaud
Indonesia	Jaewon Chung
Japan	Keita F. DeCarlo
Korea, North	Jaewon Chung
Korea, Republic of	Jaewon Chung
Laos	Ji Won Moon
Malaysia	Spencer D. Buteyn
Mongolia	Jaewon Chung
Nauru	Spencer D. Buteyn
Nepal	Ji Won Moon
New Caledonia	Spencer D. Buteyn
New Zealand	Spencer D. Buteyn
Pakistan	Ji Won Moon
Papua New Guinea	Spencer D. Buteyn
Philippines	Ji Won Moon
Singapore	Spencer D. Buteyn
Solomon Islands	Jaewon Chung
Sri Lanka	Ji Won Moon
Taiwan	Jaewon Chung
Thailand	Ji Won Moon
Timor-Leste	Jaewon Chung
Vietnam	Ji Won Moon

Europe and Central Eurasia

Albania	Jaewon Chung
Armenia	Elena Safirova
Austria	Keita F. DeCarlo
Azerbaijan	Elena Safirova
Belarus	Elena Safirova
Belgium	Loyd M. Trimmer III

Europe and Central Eurasia—Continued

Bosnia and Herzegovina	Karine M. Renaud
Bulgaria	Karine M. Renaud
Croatia	Karine M. Renaud
Cyprus	Sinan Hastorun
Czechia	Loyd M. Trimmer III
Denmark, Faroe Islands, and Greenland	Joanna Goclawska
Estonia	Keita F. DeCarlo
Finland	Joanna Goclawska
France	Keita F. DeCarlo
Georgia	Elena Safirova
Germany	Elena Safirova
Greece	Sinan Hastorun
Hungary	Loyd M. Trimmer III
Iceland	Joanna Goclawska
Ireland	Joanna Goclawska
Italy	Loyd M. Trimmer III
Kazakhstan	Elena Safirova
Kosovo	Sinan Hastorun
Kyrgyzstan	Karine M. Renaud
Latvia	Keita F. DeCarlo
Lithuania	Keita F. DeCarlo
Luxembourg	Keita F. DeCarlo
Malta	Jaewon Chung
Moldova	Elena Safirova
Montenegro	Jaewon Chung
Netherlands	Loyd M. Trimmer III
North Macedonia	Karine M. Renaud
Norway	Joanna Goclawska
Poland	Joanna Goclawska
Portugal	Joanna Goclawska
Romania	Keita F. DeCarlo
Russia	Elena Safirova
Serbia	Karine M. Renaud
Slovakia	Keita F. DeCarlo
Slovenia	Loyd M. Trimmer III
Spain	Loyd M. Trimmer III
Sweden	Joanna Goclawska
Switzerland	Keita F. DeCarlo
Tajikistan	Karine M. Renaud
Turkey	Sinan Hastorun
Turkmenistan	Karine M. Renaud
Ukraine	Elena Safirova
United Kingdom	Jaewon Chung
Uzbekistan	Elena Safirova

North America, Central America, and the Caribbean

Aruba	Yadira Soto-Viruet
The Bahamas	Yadira Soto-Viruet
Belize	Jesse J. Inestroza
Canada	James J. Barry
Costa Rica	Jesse J. Inestroza
Cuba	Yadira Soto-Viruet
Dominican Republic	Yadira Soto-Viruet
El Salvador	Jesse J. Inestroza
Guatemala	Jesse J. Inestroza
Haiti	Yadira Soto-Viruet
Honduras	Jesse J. Inestroza
Jamaica	Yadira Soto-Viruet
Mexico	Alberto A. Perez
Nicaragua	Jesse J. Inestroza
Panama	Jesse J. Inestroza
Trinidad and Tobago	Yadira Soto-Viruet

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Bolivia	Yolanda Fong-Sam
Brazil	Yolanda Fong-Sam
Chile	Yadira Soto-Viruet
Colombia	Jesse J. Inestroza
Ecuador	Jesse J. Inestroza
French Guiana	Yolanda Fong-Sam
Guyana	Yolanda Fong-Sam
Paraguay	Yadira Soto-Viruet
Peru	Yadira Soto-Viruet
Suriname	Yolanda Fong-Sam
Uruguay	Yadira Soto-Viruet
Venezuela	Yolanda Fong-Sam

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