

Exploration Review

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This summary of international mineral exploration activities during 2017 draws upon information from industry sources, published literature, SNL Metals & Mining (SNL), an offering of S&P Global Market Intelligence (New York, NY) and specialists in the U.S. Geological Survey (USGS) National Minerals Information Center. Three types of information are reported and analyzed in this annual review of international exploration: 1) budgetary statistics expressed in U.S. dollars provided by SNL; 2) regional and site-specific exploration activities that took place in 2017 as compiled by the USGS and 3) regional events and legislation that affected

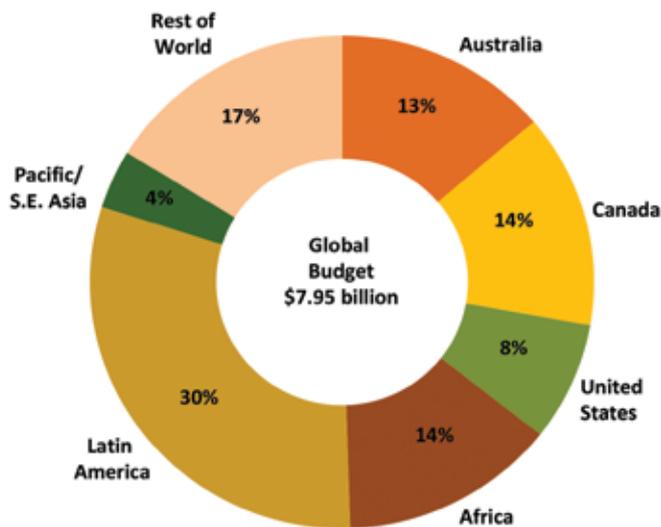
focused on precious metals (gold, platinum-group metals (PGMs) and silver), base metals (cobalt, copper, lead, molybdenum, nickel, tin and zinc), bulk commodities (bauxite, chromite, iron ore, manganese, phosphate and potash), and other commodities (aluminum, antimony, diamond, graphite, heavy-mineral sands, lithium, niobium, rare-earth elements (REEs), scandium, tantalum, tungsten, uranium, vanadium and yttrium). Information on uranium exploration activities was included in SNL's survey for the first time in 2007. Data on lithium, niobium, phosphate, potash, REE and tungsten were compiled for the first time in 2010, and scandium, vanadium and yttrium were added in 2014 because of their increased topical significance. Since 1999, companies with exploration budgets of \$100,000 and greater were included in the SNL surveys. SNL budget estimates exclude coal, and oil and gas. The 2017 SNL mining company survey compilation was reported by SNL to include an estimated 95 percent of the world's nonfuel mineral exploration budgets. The 5 percent that was not covered was accounted for by companies that chose not to participate in the SNL survey, private companies that do not publish their budget data, and government-funded exploration activities.

USGS data compilations and analyses are based on information provided by USGS mineral commodity and country specialists, as well as industry contacts and published trade journals. The USGS data summarize exploration site data collected for more than 80 minerals and materials, with a focus on base metals, diamond and precious metals. Iron ore and uranium were included in the USGS analysis after 2007. The USGS analyzed available information to assess the level of exploration activity in 2017 and to report trends in mineral exploration activity for the period 2007 through 2017. These analyses identify where mineral exploration is occurring by commodity and region, characterize the intensity of activity that is taking place in each region for selected mineral commodities, and determine those factors that most affect changes in exploration activity.

Certain limitations apply when comparing budget estimates from year to year, because as worldwide exploration allocations have changed, so too have factors such as energy, labor, material and service costs associated with mineral exploration. Consequently, an

Figure 1

Planned worldwide exploration budgets by region, 2017 (1,535 companies budgeting US\$7.95 billion). Source: SNL Metals & Mining, an offering of S&P Global Market Intelligence.



exploration activities including economic, social and political conditions, which were derived from published sources and discussions with USGS and industry specialists. Commodity and regional compilations are presented in this summary. Because multiple sources were used to develop commodity and regional compilations, statistics may vary depending on the source and type of data that are being reported.

The SNL data summarize budget estimates for worldwide exploration activities in 2017 for 30 nonfuel mineral commodities and metal alloys, based on company surveys. Surveys

exploration budget of \$1 million allocated in 2017 would generally yield less exploration activity than a corresponding budget in 2007. Fluctuations in currency exchange rates and the value of trading currencies over time can influence the business patterns of companies conducting business in other countries. Unless otherwise specified, this analysis expresses worldwide exploration activity in U.S. nominal (current) dollars to simplify comparisons by commodity and region. The level of exploration investment may also be influenced by the scale of the planned operation; development of a large-scale operation usually requires a greater exploration investment than a small-scale operation with a shorter project life.

Temporal interpretations of the exploration data, such as trend analyses, may be limited by changes in survey parameters. SNL survey data and USGS-compiled site data can vary based on the level of information reported by companies, the number of surveyed companies and their response rates, and fluctuation of currency exchange rates affecting the relative value of budget estimates from year to year. Mineral commodity and country coverage may differ from year to year as corporate restructuring within the mining industry has taken place.

2017 global mineral exploration activity and trends from 2007 through 2017

According to SNL, the estimated worldwide budget allocation for nonferrous mineral exploration increased by 14 percent in 2017 to about \$7.95 billion (on the basis of data from 1,535 companies, excluding iron ore) from the 2016 budget allocation of about \$6.95 billion (based on 1,580 companies, excluding iron ore).

The industry continued to recover from the recession of 2007-2009. As metals prices increased, metals demand in China was higher than forecast by some analysts, and investors showed greater willingness to fund exploration projects. Although the cumulative exploration budget for junior companies reported by SNL, which derive their cash flow from public and private investors, increased from 26 percent of the global exploration budget in 2016 to

28 percent in 2017, their budget is still much lower than the 55 percent allocation in 2007. From 2012 through 2015, budget allocation decreased for all commodities. In 2016 and 2017, allocations for cobalt, gold and lithium increased significantly, budget allocations for base metals increased modestly, and budget allocations for diamond, PGMs and uranium decreased. As demand for minerals used in the growing lithium battery market increased, exploration for these minerals also increased. The exploration budget for lithium, for example, has increased from \$22 million in 2015 to \$128 million in 2017, and the number of companies exploring for lithium increased from 23 in 2015 to 125 in 2017.

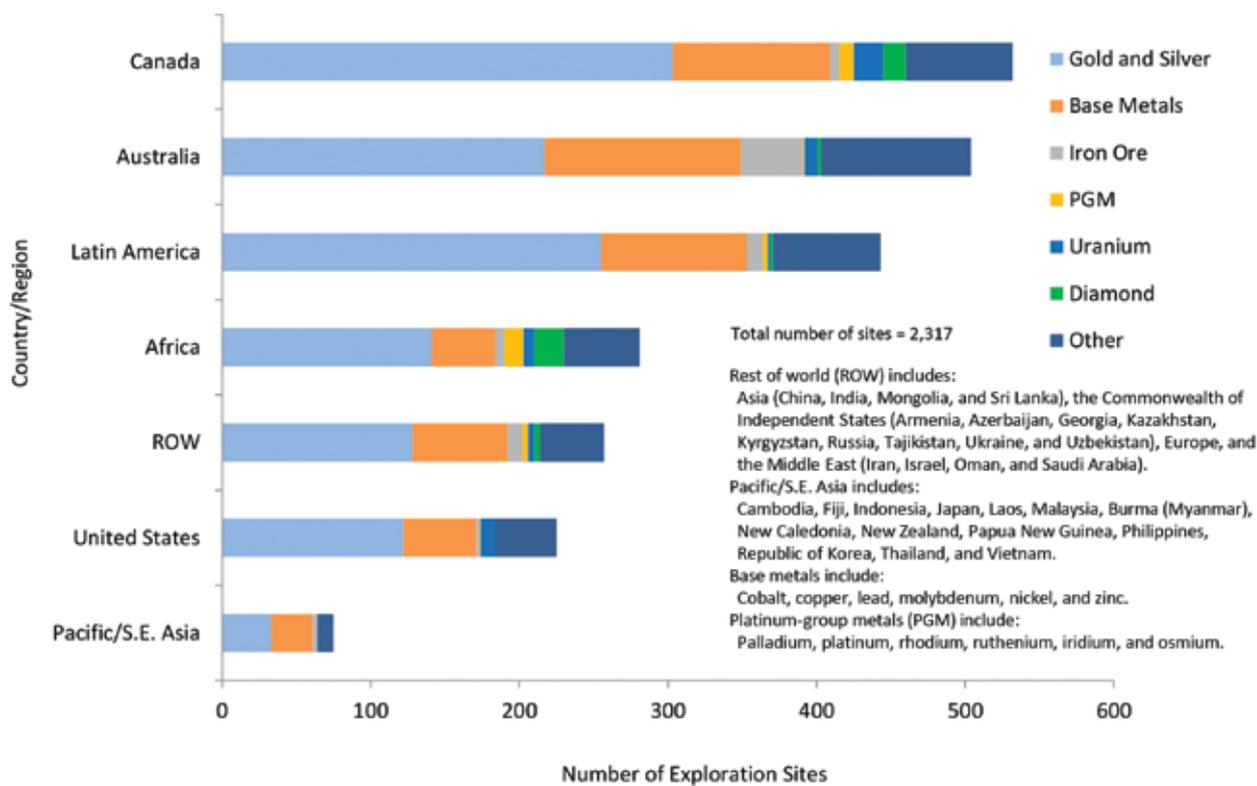
Figure 1 shows the 2017 worldwide nonfuel minerals exploration budgets allocated by region, based on SNL data. SNL “regions” reflect a mixture of individual countries, continents and other groupings, but they are reported consistently on an annual basis and provide a means of assessing the flow of budgeted exploration expenditures from year to year. Latin America remained the region with the largest mineral exploration budget, expressed either in nominal dollars or percent of the global exploration budget, followed by Canada, Africa, Australia, the United States and the Pacific/S.E. Asia region.¹ Exploration taking place in countries included in the “Rest of the World (ROW)” accounted for 17 percent of the global exploration budget. The exploration budgets in 2017 for all regions except the Pacific/S.E. Asia were higher than the corresponding budget in 2016. Year-to-year changes in budgets listed in descending order were: Latin America (20 percent), the United States (19 percent), Australia (19 percent), Africa (18 percent), Canada (12 percent) and the Pacific/S.E. Asia (decrease of 18 percent). The countries comprising the ROW reported a budget increase of 9 percent.

For 2017, data on 2,317 exploration sites were gathered by USGS specialists from published literature and industry sources. The regional distribution of these exploration targets are represented in Fig. 2 by principal commodity target. Canada was the leading

¹ As defined by SNL, Africa includes countries on the African continent. Latin America includes countries in the Caribbean, Central America, Mexico and South America. The Pacific/S.E. Asia region includes Fiji, Indonesia, Japan, the Korean peninsula, Laos, Malaysia, New Caledonia, New Zealand, Papua New Guinea, Philippines, Solomon Islands, Thailand, Vanuatu and Vietnam. The Rest of the World includes Asia (Afghanistan, China, India, Mongolia, Sri Lanka and Pakistan), the republics of the Commonwealth of Independent States (Azerbaijan, Armenia, Belarus, Georgia, Kazakhstan, Kyrgyzstan, Moldova, Russia, Tajikistan, Turkmenistan, Uzbekistan and Ukraine), Europe and the Middle East (Cyprus, Iran, Israel, Oman, Saudi Arabia and Yemen). Australia, Canada and the United States are treated separately.

Figure 2

Number of active exploration sites by region in 2017. Site data were compiled by the U.S. Geological Survey based upon copyrighted data from SNL Metals & Mining, an offering of S&P Global Market Intelligence and other published data.



area in terms of active exploration sites in 2017, followed by Australia, Latin America, Africa, the ROW, the United States and the Pacific/S.E. Asia. The number of sites that are actively being explored does not correlate directly with exploration budget estimates, but both are indicators of activity in the region of interest. SNL and USGS data suggest that Latin America and the ROW region had the highest average exploration budget per site, whereas Australia and Canada had the lowest average exploration budget per site. Based on the USGS data compilation, approximately 48 percent of active exploration sites in Latin America had achieved at least the feasibility stage of exploration in 2017, 39 percent of the active sites in Australia had achieved feasibility stage, and 25 percent in Canada had achieved feasibility stage.

Based on mineral exploration drilling data collected by SNL, the number of exploration drill holes completed in 2017 was 59 percent greater than the number of holes drilled in 2016. In spite of this, the number and nominal value of resources identified by this drilling activity decreased by nearly 57 percent in 2017 from the resources identified by SNL based on 2016 drilling. Drilling in Australia, Canada, and the United States together accounted for about 65 percent of the number of holes

drilled globally in 2017. SNL does not report aggregated information on the total length of drilling conducted in a region or country.

Figure 3 summarizes SNL budget data by region for the period 2007 through 2017. The top chart of Fig. 3 suggests that 2017 may reflect the beginning of a recovery from the trend of decreasing exploration budgets that are reported for the 2012-2016 period. The middle chart of Fig. 3 shows the trend in global exploration budgets in terms of both nominal (current) dollars and real (constant) dollars. The bottom chart of Fig. 3 shows percentages of the world exploration budget by region. Since exploration activity peaked in 2012, there has been steady growth in relative activity in the ROW (primarily China, India and parts of Europe) and Latin America, while relative activity associated with Africa, Canada and the Pacific/S.E. Asia regions have declined based on percentage of the total annual exploration dollars spent in these regions.

Since 2007, the percentage of the total global exploration budget attributed to mine-site exploration has generally increased while early-stage exploration has decreased. The SNL mineral exploration survey data suggest that budgeted expenditures in 2017 for exploration associated with established mine sites accounted for about 37 percent and

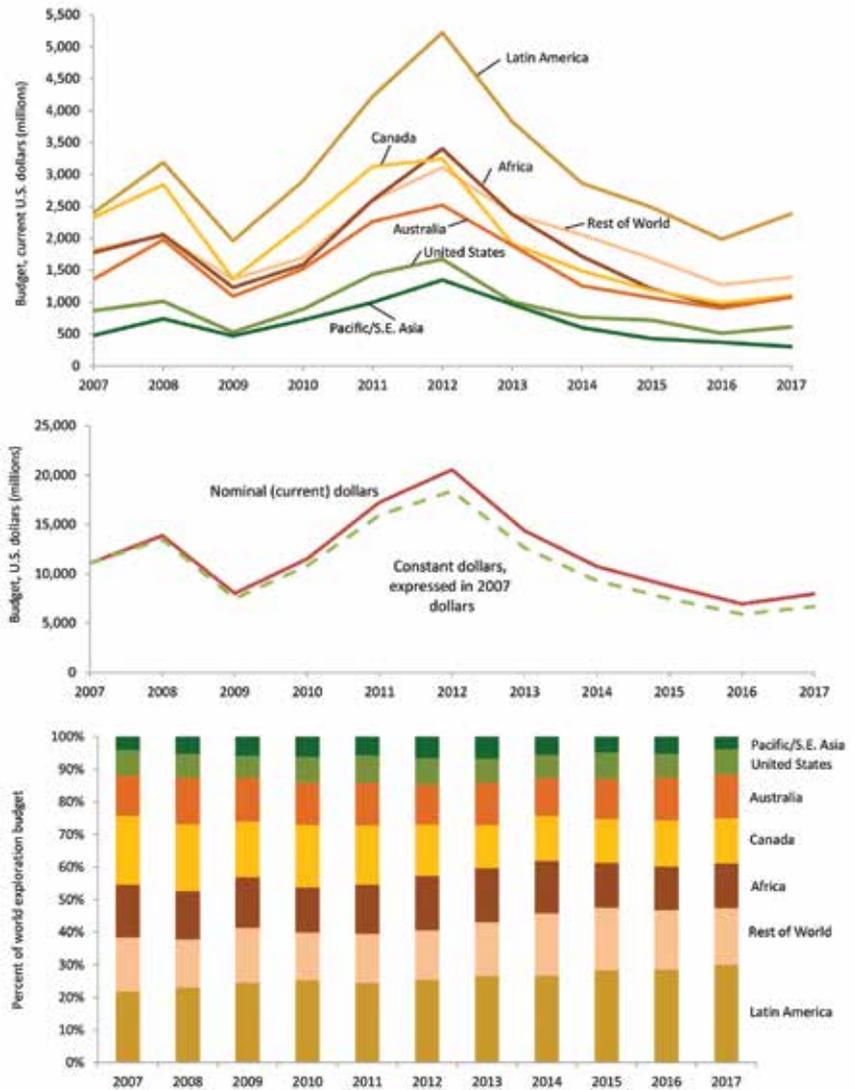
Figure 3

Trends in reported exploration budgets in selected regions, 2007 through 2017.
Source: SNL Metals & Mining, an offering of S&P Global Market Intelligence.

sites at a late stage of exploration accounted for about 36 percent of the total global exploration budget, and early-stage sites accounted for about 27 percent, compared with the 2007 values of 19, 40 and 41 percent, respectively. Companies shifted their exploration focus toward projects targeted for short-term development in order to make them attractive for acquisition, or as a less expensive means of replacing or adding reserves. Traditionally, major companies leave early-stage exploration to junior companies. For the period 2013-2016, many junior companies had difficulty securing sufficient financing to conduct extensive exploration, which often required more than \$500,000 for an initial drilling program. Consequently, larger companies (major and intermediate companies) contributed a greater share of exploration, accounting for about 65 percent of the exploration allocation in 2017. However, the junior share increased from 26 percent of the total exploration budget in 2016 to 28 percent in 2017, as they were more successful in raising private capital for their projects.

Many exploration projects are becoming increasingly more costly and difficult to develop. Depletion of known shallow deposits has driven exploration companies to explore for deeper deposits and to look in areas that have traditionally been more cost intensive and technically challenging. Exploration companies are also looking for high-grade deposits in remote areas with limited infrastructure or under covered terrain, and offshore mineral exploration has increased. In South Africa, for example, older, high-cost mines that do not lend themselves to mechanization are being phased out in favor of highly-mechanized mines. In 2015, only 30 percent of the country's PGMs production originated from mechanized mines.

Recent and anticipated mineral commodity prices influence exploration budget development and the amount of activity planned by mineral exploration companies. Table 1 shows the average annual prices in current (nominal) dollars of selected metals for the years 2007 through 2017. However, because of metal price variation, reporting just the average prices for the year does not provide



enough information to assess the effect of price changes on the level of exploration. Figure 4 shows the annual prices in 2007 constant U.S. dollars for the selected mineral commodities shown in Table 1 for 2007-2017. Using constant dollar values based on the Consumer Price Index reduces the effects of inflation on prices of mineral commodities being considered over time as reported by the U.S. Bureau of Labor Statistics.

The period 2016-2017 appeared to be a turning point for many metals prices. Of the mineral commodities tracked in this analysis, average 2016 nominal prices for gold, lead, lithium carbonate, silver and zinc increased from average 2015 prices, and average 2017 prices for copper, gold, lead, lithium carbonate, nickel, palladium and zinc were higher in 2017 than in 2016.

Table 1

Prices for selected base and precious metals, 2007 through 2017.

Commodity	Average nominal price for specified year, expressed in U.S. currency										
	2007 ¹	2008 ¹	2009 ¹	2010 ¹	2011 ¹	2012 ¹	2013 ¹	2014 ^{1,2}	2015 ^{1,2}	2016 ²	2017 ²
Copper ³	3.28	3.19	2.41	3.48	4.06	3.67	3.40	3.18	2.56	2.25	2.85
Gold ⁴	699	874	975	1,230	1,572	1,673	1,415	1,269	1,163	1,252	1,261
Lead ^{5,6}	1.24	1.20	0.87	1.09	1.22	1.14	1.10	1.06	0.91	0.94	1.14
Nickel ⁷	16.88	9.57	6.65	9.89	10.38	7.95	6.81	7.65	5.37	4.35	4.60
Palladium ⁸	357	355	266	531	739	649	730	810	695	617	874
Platinum ⁹	1,308	1,578	1,208	1,616	1,725	1,555	1,490	1,388	1,056	990	951
Silver ¹⁰	13.41	15.00	14.69	20.04	35.28	31.22	23.89	19.09	15.72	17.20	17.16
Uranium oxide ¹¹	99.33	61.71	46.06	46.84	56.34	48.40	38.17	33.21	36.55	25.64	21.66
Zinc ¹²	1.47	0.85	0.75	0.98	0.99	0.88	0.87	0.98	0.88	0.95	1.30
Lithium carbonate ¹³	NA	NA	NA	2.35	2.35	2.75	3.08	3.03	2.95	3.92	6.30

¹ Price reported in U.S. Geological Survey (USGS) Minerals Yearbook series for the years 2007 through 2013.
² Price for selected commodities reported in USGS Minerals Commodity Summaries series for the years 2014 and 2017 or updated based on oral and written communications, USGS mineral commodity specialists.
³ U.S. producer cathode (minimum 99.99% pure), reported in dollars per pound.
⁴ Englehard Corporation industries quotation, reported in dollars per troy ounce.
⁵ North American producer price, delivered (minimum 99.97% pure), in dollars per pound. Reported for 2007-2012.
⁶ North American market price, delivered (minimum 99.97% pure), in dollars per pound. Reported for 2013-2017.
⁷ London Metal Exchange cash price for primary nickel (minimum 99.80% pure), in dollars per pound.
⁸ Unfabricated palladium, reported in dollars per troy ounce.
⁹ Unfabricated platinum, reported in dollars per troy ounce.
¹⁰ Handy & Harmon quotation (2007-2009); Englehard Corporation quotation (2010-2017), reported in dollars per troy ounce.
¹¹ Cameco spot price, reported in dollars per pound by Ux Consulting and TradeTech.
¹² London Metal Exchange cash price, reported in dollars per pound.
¹³ Industrial Minerals quotation, battery-grade lithium carbonate, large contracts, delivered continental United States, in dollars per pound.

Mineral prices in 2017 may reflect the start of a price recovery period, but metal prices are still well below the price peak of 2012. The average 2017 constant-dollar prices of copper, lead, nickel, palladium, lithium carbonate and zinc were greater than their average 2016 constant-dollar prices, whereas the average 2017 constant-dollar prices of gold, platinum, silver and uranium were lower than their average 2016 constant-dollar prices. The 2017 average constant-dollar price for uranium was 58 percent below its average constant-dollar price for the past 10 years; similarly, the 2017 nickel price was 49 percent lower than its 10-year average; the 2017 platinum price was 33 percent below its 10-year average; the 2017 silver price was 21 percent below its 10-year average and the 2017 copper price was 16 percent below its 10-year average. Prices for gold and lead were near their 10-year average. On the other hand, the 2017 constant-dollar price for lithium carbonate was 82 percent higher than its 10-year average; the 2017 price for palladium was 36 percent higher than its 10-year average; and the 2017 zinc price was 31 percent higher than its 10-year average. Prices for these three mineral commodities reflect the perception that they are in short supply compared to projected short-term demand.

Mineral exploration companies consider historical and future trends of metals prices, along with projections of supply and demand that underpin prices, to determine where and on what commodity target to spend available

capital on exploration and development. Commodity price movements can also alter the calculation of known reserves and decisions on exploration expenditures and targets. During the period of increasing gold price that took place from 2006 through 2012, the major gold miners increased the recovery of gold from lower ore grades and were able to maintain a satisfactory profit level, and some exploration companies re-evaluated deposits with historically lower ore grades. The average gold price in 2017 was 25 percent lower than the peak gold price in 2012. In response to recovering prices for many mineral commodities, some companies increased budgeted expenditures for exploration spending, while others announced plans to increase investment in mineral exploration if financing could be secured.

Currency movements were an important consideration for the minerals exploration and mining sector in 2017. In 2017, the U.S. dollar recorded its first annual decline in five years, according to the ICE Dollar Index, which measures the dollar against six other currencies. A weak U.S. dollar makes U.S. mining-related exports less expensive for other countries and decreases the costs associated with foreign projects that purchase goods or supplies using U.S. dollars. With most commodities priced in U.S. dollars, however, a weaker dollar may increase costs incurred in local currencies.

Ernst & Young Global Limited estimated the greatest business risks for the mining and

Figure 4

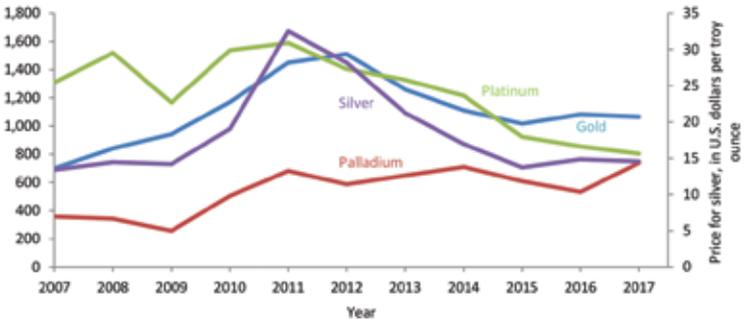
Average constant dollar prices for selected (a) precious metals, (b) base metals, and (c) other selected mineral commodities for the period 2007 through 2017. Nominal dollar prices from various sources were indexed using the Consumer Price Index with a base year of 2007.

minerals exploration industry in 2017-2018, in order of importance, as: effectiveness of digital technology to improve productivity and margin, competitive shareholder returns, cyber risks, new world commodities, regulatory risk, cash optimization, social license to operate, resource replacement, access to and optimization of energy and managing joint ventures.

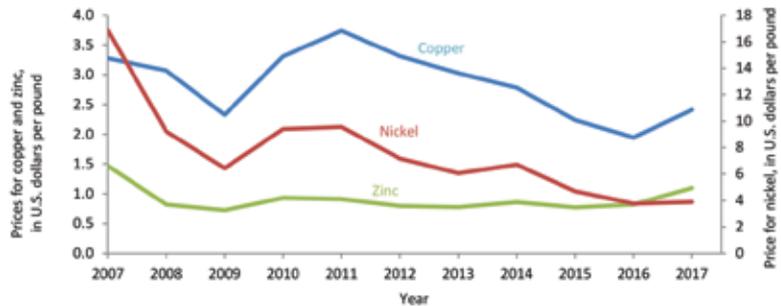
Since the beginning of the 21st century, the global landscape for mineral exploration and development has changed. At the end of the 20th century, the bulk of global mineral exploration was conducted by Australian, Canadian and U.S. companies. Companies headquartered in these countries continue to explore globally and generated the greatest exploration budgets in 2017, but SNL data suggest that the share of companies headquartered in these three countries has declined from about 69 percent in 2007 to about 56 percent in 2017.

Over the past few years, declining metals prices, excess mineral supply, reduced demand for metals in China and languishing company earnings have made investors wary of the mining sector. Capital expenditures by both major and junior companies declined from 2012 through 2016; miners have focused on a strategy of retrenchment, project prioritization and divestment of high-cost or noncore assets. In 2017, 1,167 companies were reported to have a negligible exploration budget, either because they required additional funding to conduct exploration activities (37 percent, down from 45 percent in 2016), or because they were focusing on securing joint venture deals to finance exploration permitting issues or legal and/or access concerns limited exploration, or the companies had not yet developed an exploration plan for a newly acquired project.

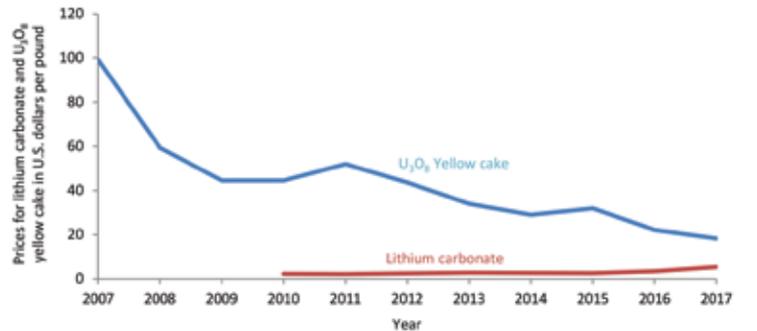
Exploration and mining investment has shifted from these traditional jurisdictions to virtually all countries. In 2012, exploration in Brazil, Russia, India and China (BRIC) accounted for about 10 percent of the global exploration budget; by 2016, these countries accounted for about 15 percent of the global exploration budget, even though the combined



a. Average constant dollar prices for selected precious metals from 2007 through 2017.



b. Average constant dollar prices for selected base metals from 2007 through 2017.



c. Average constant dollar price for lithium carbonate from 2010-2017 and for U₃O₈ yellow cake for 2007-2017.

2016 budget for these countries in constant-dollars was about half of the combined budget for these countries in 2012. In 2017, exploration allocation for the BRIC countries had decreased to 13 percent, even though the combined exploration budget for these countries had increased from the 2016 level.

The year 2017 appears to reflect the beginning of a recovery for mineral exploration, with increased financing, more exploration activity and greater sector optimism. In 2017, some key metal prices began to increase, primarily reflecting stronger Chinese economic activity, increased demand for selected metals, and lower production of some metals from China because of increased environmental regulation. This has led to signs of increased

financings by juniors and some growth in exploration drilling toward the end of the year. While global mergers and acquisitions (M&A) for gold, copper, nickel and potash continue to decline, M&A for iron ore, steel and silver-lead-zinc saw more activity.

Competing demand for energy and water have increased risks related to energy and water access. As ore grades decline and exploration takes place in more remote locations, the mining sector in Australia, Canada, Chile and South Africa increased its focus on increasing access to or developing new techniques to use desalinated water and renewable energy sources in order to reduce energy consumption and adopt more sustainable energy sources.

As global demand for natural resources continues to grow, there is increasing exploration of the ocean floor for its resource potential. In 2007, Nautilus Minerals was one of the first companies to begin exploration for massive sulfides off the coast of Papua New Guinea; the company expects to begin mining base and precious metals as early as 2019. The International Seabed Authority, an autonomous international organization established under 1994 provisions of the United Nations Convention on the Law of the Sea, has approved 29 contracts for exploration covering more than 1.3 million km² (502,000 sq miles) of seabed by 2017. In 2017, exploration was reported to be ongoing off the coast of India for cobalt-bearing ferromanganese, manganese and phosphate; Namibia for diamond; New Zealand for iron sands and the Philippines for polymetallic sulfide minerals. Most of these activities are at an early stage.

The government of Luxembourg passed a law in 2017 that defines the conditions companies must fulfill to obtain a license for launching a space mining mission of asteroids. Russia and China signed an agreement creating an organizational and legal basis for preventing unauthorized access to and transfer of protected space exploration technologies. Actual space mineral exploration has not yet begun.

Exploration activity by mineral commodity

The amount budgeted for gold exploration in 2017 (\$4 billion) based on SNL data was 22 percent higher than that budgeted in 2016. Figure 5 illustrates the 2013 through 2017 global percent share distribution of reported mineral exploration budget estimates by mineral commodity grouping. The percent share attributed to global gold exploration

relative to exploration for all nonfuel minerals decreased for the years 2013 through 2014 then increased from 2015 to 2017. In terms of percentage of worldwide nonfuel exploration budget, exploration for gold accounted for 51 percent in 2017, compared to 48 percent in 2016 and 45 percent in 2015.

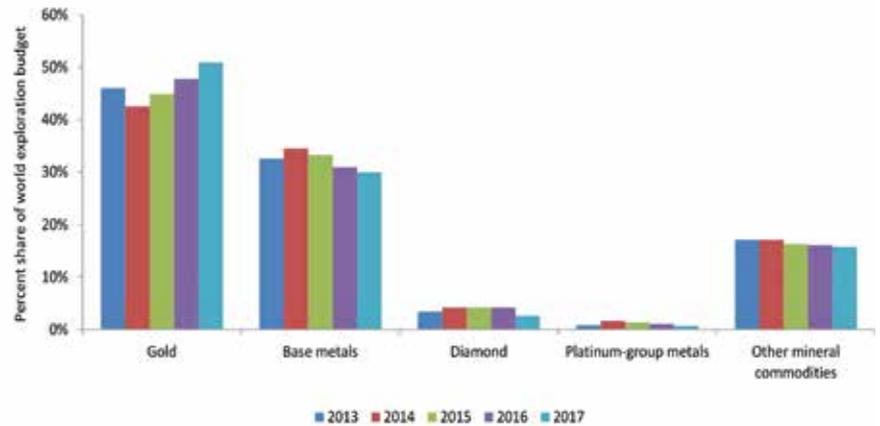
Latin America remains the leading region for gold exploration, accounting for about 26 percent of gold budget allocations based on SNL data. Canada accounted for about 17 percent of the global gold budget, Africa and Australia each accounted for about 16 percent and the United States accounted for about 9 percent. In 2017, major companies accounted for about 54 percent of the gold exploration budget, while junior companies accounted for about 29 percent. Exploration for gold focused on existing mine sites (42 percent), late-stage deposits (35 percent) and early-stage deposits (23 percent).

Exploration budgets for base-metal projects increased 11 percent from \$2.1 billion in 2016 to \$2.4 billion in 2017. In terms of percentage of total worldwide nonfuel exploration budget, the estimated base-metal exploration budget decreased to 30 percent in 2017 from 31 percent in 2016. The percent allocation for base-metal exploration increased from 2013 through 2014 then decreased from 2015 through 2017, mainly because of exploration focused on copper. Exploration for copper accounted for about 69 percent of the base-metal budget for 2017, lead and zinc exploration accounted for about 21 percent and nickel exploration accounted for 10 percent. The leading three countries for copper exploration in 2017, based on SNL budgets, in descending order, were Chile, Peru and Australia, together accounting for about 43 percent of the global copper exploration budget. The leading three countries for lead/zinc exploration in 2017, in descending order, were Peru, China and Mexico, together accounting for about 38 percent of the global lead/zinc exploration budget. The leading three countries for nickel exploration in 2017 in descending order were Canada, Australia and Russia, together accounting for about 59 percent of the global nickel exploration budget.

The budget for diamond exploration decreased 28 percent in 2017 from 2016 and 60 percent since 2012. The diamond exploration budget of about \$208 million in 2017 represented less than 3 percent of the global exploration budget, about the same as its share in 2012. The three leading locations for diamond exploration, in descending order by 2017 budget, were Russia, Canada and

Figure 5

Worldwide exploration budgets for selected mineral commodity targets, 2013-2017. (Other minerals include iron ore, lithium, molybdenum, niobium, phosphate, potash, rare-earth elements, silver, tantalum, tin and uranium. Expressed as a percentage of nominal dollar budget.) Source: SNL Metals & Mining, an offering of S&P Global Market Intelligence.



Botswana, together accounting for about 79 percent of the global exploration budget for diamond.

The exploration budget estimate in 2017 for PGMs of \$56 million represented a 15-year low. The SNL budget estimate was 24 percent lower than the 2016 budget estimate and represented less than 1 percent of the global exploration budget for 2017. The three leading locations for PGMs exploration, in descending order, were Russia, South Africa and Canada, together accounting for about 85 percent of the global exploration budget for PGMs. The decline in PGMs exploration reflects decreased demand from the chemical, electrical, glass and petroleum sectors.

The estimated global budget for other mineral commodity targets was 20 percent higher in 2017 than the budget reported for 2016. Mineral commodities considered in this category include but are not limited to graphite, heavy-mineral sands, lithium, manganese, molybdenum, niobium, phosphate, potash, REEs, silver, tantalum, tin, tungsten and uranium. The increased demand for lithium-based batteries influenced the search for minerals considered by many to be critical to the automotive sector. The exploration budget for lithium doubled from its 2016 exploration budget and increased about fourfold from its 2015 budget. The USGS identified 167 active exploration sites for lithium in 2017 compared to 56 in 2012. Cobalt exploration, in terms of the number of active sites, increased 121 percent between 2016 and 2017.

The budget estimate for uranium exploration decreased about 10 percent to \$256 million in 2017 from about \$284 million in 2016. The global nuclear industry has not yet returned to its pre-Fukushima level, as safety concerns remained high, and there was an increased focus on renewable energy sources. The three leading locations for exploration of uranium in 2017 were Canada, Australia and Kazakhstan, together accounting for about 68 percent of the global exploration budget for uranium.

Based on global exploration site data compiled by the USGS, gold was the principal target at 47 percent of the sites explored in 2017; copper was the target at 12 percent of the sites; lithium was the target at 7 percent of the sites; silver and lead/zinc each represented about 5 percent of the sites; iron

ore represented about 4 percent of the sites; nickel represented about 3 percent of the sites; and graphite, uranium, and diamond each represented about 2 percent of the sites. Approximately 11 percent of the sites were being explored for other minerals. Both the SNL and USGS data support the conclusion that there was continued interest in exploration for graphite, lithium, potash, REEs and tungsten, but, with the exception of lithium, the number of companies exploring for these commodities has declined from the 2012 peak.

2017 exploration highlights

Table 2 presents selected noteworthy exploration sites based on the amount of exploration activity conducted in 2017. The USGS does not assume responsibility for errors or omissions. A combined total of about 5.3 million m (17.4 million ft) of drilling took place in 2017 on the sites included in Table 2. The following criteria were used as a basis for site inclusion:

- The high level of exploration interest at a site, determined by intensity of drilling activity, level of planned and executed exploration budget, or the magnitude of additional resources delineated based on 2017 work. When drilling was used as the principal indicator, a site qualified if a minimum of 20,000 m (65,600 st) of drilling (usually a combination of diamond or reverse-circulation drilling) took place during 2017 along with ancillary exploration activities. Where budget

Table 2

Selected noteworthy exploration sites for 2017.

Location	Type ¹	Site	Commodity	Company	Resource ² notes
Africa					
1 Burkina Faso	F	Boungou/Natougou	Au	SEMAFO Inc.	1.5 Moz Au (R)
2 Burkina Faso	P	Mana	Au	SEMAFO Inc.	1.7 Moz Au (R)
3 Burkina Faso	F	Sanbrado	Au	West African Resources Ltd.	894,000 oz Au (R)
4 Burkina Faso	E	South Hounde	Au	Sarama Resources Ltd.	2.1 Moz Au (IF)
5 Burkina Faso	P	Yaramoko	Au	Roxgold Inc.	738,000 oz Au (D)
6 Congo, Dem. Rep. of	E	Kamoa-Kakula	Cu	Ivanhoe Mines Ltd.	4.8 Mt Cu (R)
7 Côte d'Ivoire	P	Agbaou	Au	Endeavor Mining Corp.	853,000 oz Au (R)
8 Côte d'Ivoire	E	Doropo	Au	Centamin plc	300,000 oz Au (D)
9 Côte d'Ivoire	F	Mt. Yaoure	Au	Perseus Mining Ltd.	1.5 Moz Au (R)
10 Egypt	P	Sukari	Au	Centamin plc	8.0 Moz Au (R)
11 Kenya	E	West Kenya/ Kakamega	Au	Acacia Mining plc	1.3 Moz AU (IF)
12 Mali	P	Fekola	Au	B2Gold Corp.	3.7 Moz Au (R)
13 Mali	P	Tabakoto	Au	Endeavor Mining Corp.	615,000 oz Au (R)
14 Mauritania	E	Tijirit	Au	Algold Resources Ltd.	43,000 oz Au (D)
15 South Africa	F	Prieska	Zn, Cu, Au, Ag	Orion Minerals NL	873 kt Zn, 297 kt Cu, 163 koz Au, 7.2 Moz Ag (IF)
16 South Africa	F	Waterberg	Pt, Pd, Au, Rh, Cu, Ni	Platinum Group Metals Ltd.	3.7 Moz Pt, 7.6 Moz Pd, 950 koz Au, 120,000 oz Rh, 83 kt Cu, 154 kt Ni (R)
17 Tanzania	P	Bulyanhulu	Au, Cu, Ag	Acacia Mining plc	4.9 Moz Au, 86 kt Cu, 4.1 Moz Ag (R)
Australia					
18 New South Wales	E	McPhillamys	Au	Regis Resources Ltd.	2 Moz Au (R)
19 Northern Territory	P	Cosmo Howley	Au	Kirkland Lake Gold Inc.	55 koz Au (D)
20 Queensland	P	Matilda & Wiluna	Au	Blackham Resources Ltd.	1.7 Moz Au (IF)
21 Western Australia	P	Carosue Dam	Au	Saracen Mineral Holdings Ltd.	907,000 oz Au (R)
22 Western Australia	E	Doolgunna	Cu	Sandfire Resources Ltd.	Data not released.
23 Western Australia	P	Duketon	Au	Regis Resources Ltd.	987,000 oz Au (R)
24 Western Australia	P	East Kundana JV	Au	Northern Star Resources Ltd.	603,000 oz Au (R)
25 Western Australia	E	Fraser Range	Ni	Independence Group NL	Data not released.
26 Western Australia	E	Lake Roe	Au	Breaker Resources NL	Data not released.
27 Western Australia	F	Leonora	Au	Kin Mining NL	373,000 oz Au (R)
28 Western Australia	P	Mungari	Au	Evolution Mining Ltd.	602,000 oz Au (R)
29 Western Australia	P	Nova-Bollinger	Ni, Cu, Co	Independence Group NL	274 kt Ni, 110 kt Cu, 9 kt Co (R)
30 Western Australia	P	Nullagine	Au	Millennium Minerals Ltd.	224,900 oz Au (R)
31 Western Australia	E	Redcliffe	Au	NTM Gold Ltd.	84,000 oz Au (D)
32 Western Australia	E	Tampia Hill	Au	Explaurum Ltd.	620,500 oz Au (D)
33 Western Australia	P	Tropicana	Au	Anglogold Ashanti Ltd.	4.1 Moz Au (R)
34 Western Australia	F	Yamarna (Gruyere JV)	Au	Gold Fields Ltd.	3.5 Moz Au (R)
Canada					
35 British Columbia	E	Island Mountain	Au	Barkerville Gold Mines Ltd.	Data not released.
36 British Columbia	E	Premier	Au, Ag	Ascot Resources Ltd.	2.5 Moz Au, 21 Moz Ag (D)
37 British Columbia	E	Valentine Lake	Au	Marathon Gold Corp.	1.8 Moz Au (D)
38 Nova Scotia	D	Moose River Conso. (Fifteen Mile Stream)	Au	Atlantic Gold Corp.	452,000 oz Au (D)
39 Nunavut	E	Amaruq	Au	Agnico Eagle Mines Ltd.	2.1 Moz Au (D)
40 Ontario	P	Detour Lake	Au	Detour Gold Corp.	16.4 Moz Au (R)
41 Ontario	E	Garrison	Au	Osisko Mining Inc.	1.2 Moz Au (D)
42 Ontario	E	Goldlund	Au	First Mining Finance Corp.	560,000 oz Au (D)
43 Ontario	P	Island Gold	Au	Alamos Gold Inc.	752,000 oz Au (R)
44 Ontario	P	Macassa/So. Claims	Au	Kirkland Lake Gold Inc.	2 Moz Au (R)
45 Ontario	E	Madsen	Au	Pure Gold Mining Inc.	1.6 Moz Au (ID)
46 Ontario	P	Porcupine	Au	Goldcorp Inc.	8.1 Moz Au (R)
47 Ontario	D	Sugar Zone	Au	Harte Gold Corp.	714,000 oz Au (ID)
48 Ontario	P	Taylor	Au	Kirkland Lake Gold Inc.	129,000 oz Au (R)
49 Ontario	P	Timmins West/144	Au	Tahoe Resources Inc.	738,000 oz Au (R)
50 Quebec	P	Canadian Malartic/Odyssey	Au	Agnico Eagle Mines Ltd.	7.1 Moz Au (R)
51 Quebec	E	Clearwater	Au	Eastmain Resources Inc.	826,000 oz Au (D)
52 Quebec	E	Gladiator	Au	Bonterra Resources Inc.	273,000 oz Au (IF)
53 Quebec	E	James Bay Lithium	Li	Galaxy Resources Ltd.	571 kt Li ₂ O (ID)
54 Quebec	E	Lamaque	Au	Eldorado Gold Corp.	1.5 Moz Au (D)
55 Quebec	E	Orenada	Au	Alexandria Minerals Corp.	385,000 oz Au (D)

Location	Type ¹	Site	Commodity	Company	Resource ² notes
56 Quebec	E	Rouyn	Au	Yorbeau Resources Inc.	398,000 oz Au (D)
57 Quebec	E	Rouyn-Noranda	Zn, Au	Falco Resources Ltd.	Data not released.
58 Quebec	E	Val d'Or East	Au	Probe Metals Inc.	770,000 oz Au (IF)
59 Quebec	E	Windfall Lake	Au	Osisko Mining Inc.	748,000 oz Au (D)
60 Saskatchewan	F	Rook I	U	NexGen Energy Ltd.	81 kt U ₃ O ₈ (ID)
61 Yukon Territory	E	Blende	Zn, Pb, Ag	Blind Creek Resources Ltd.	596 kt Zn, 549 kt Pb, 35 Moz Ag (IF)
62 Yukon Territory	F	Coffee	Au	Goldcorp Inc.	2.2 Moz Au (PR)
63 Yukon Territory	D	Dublin Gulch	Au	Victoria Gold Corp.	2.7 Moz Au (R)
Latin America					
64 Argentina	E	Salar de Cauchari	Li, K	Advantage Lithium Corp.	88 kt Li, 1.6 Mt KCl (IF)
65 Argentina	E	Mariana	Li	Jiangxi Ganfeng Lithium Co.	1.2 Mt LCE (ID)
66 Argentina	D	Cerro Moro	Au, Ag	Yamana Gold Inc.	715,000 oz Au, 41 Moz Ag (R)
67 Argentina	P	Cerro Negro	Au, Ag	Goldcorp Inc.	4.9 Moz Au, 36 Moz Ag (R)
68 Argentina	P	Gualcamayo	Au	Yamana Gold Inc.	754,000 oz Au (R)
69 Brazil	P	Tucano	Au	Beadell Resources Ltd.	1.5 Moz Au (R)
70 Brazil	P	Turmalina	Au	Jaguar Mining Inc.	171,000 oz Au (R)
71 Chile	P	Candelaria	Cu, Au, Ag	Lundin Mining Corp.	2.8 Mt Cu, 2.1 Moz Au, 31 Moz Ag (R)
72 Chile	P	El Penon	Au, Ag	Yamana Gold Inc.	1.1 Moz Au, 36 Moz Ag (R)
73 Chile	P	Minera Florida	Au, Ag, Zn	Yamana Gold Inc.	468,000 oz Au, 3.5 Moz Ag, 61 kt Zn (R)
74 Colombia	E	San Matias	Cu, Au	Cordoba Minerals Corp.	375 kt Cu, 637, 000 oz Au (IF)
75 Ecuador	E	Cascabel	Cu, Au	SolGold plc	2.2 Mt Cu, 5.5 Moz Au (ID)
76 Mexico	E	El Barqueño	Ag, Au	Agnico Eagle Mines Ltd.	301,000 oz Au, 1.2 Moz Ag (ID)
77 Mexico	P	La Guitarra	Ag, Au	First Majestic Silver Corp.	9.1 Moz Ag, 49,000 oz Au (R)
78 Mexico	P	La Parrilla	Ag, Au, Pb, Zn	First Majestic Silver Corp.	8.5 Moz Ag, 2,600 oz Au, 14 kt Pb, 12 kt Zn (PR)
79 Mexico	E	Las Chispas	Ag, Au	SilverCrest Metals Inc.	Data not released.
80 Mexico	P	Los Filos	Au, Ag	Leagold Mining Corp.	1.5 Moz Au, 9.7 Moz Ag (R)
81 Mexico	P	Palmarejo	Ag, Au	Coeur Mining Inc.	47 Moz Ag, 706 koz Au (R)
82 Mexico	P	Pinos Altos	Au, Ag	Agnico Eagle Mines Ltd.	1.4 Moz Au, 38 Moz Ag (R)
83 Mexico	P	San Martin	Ag, Au	First Majestic Silver Corp.	15 Moz Ag, 21 koz Au (R)
84 Nicaragua	P	La Libertad	Au	B2Gold Corp.	119,000 oz Au (R)
85 Suriname	E	Saramacca	Au	IAMGOLD Corp.	1 Moz Au (ID)
United States					
86 Alaska	E	Tetlin	Au, Ag, Cu	Contango Ore Inc.	1.2 Moz Au, 4.8 Moz Ag, 17 kt Cu (D)
87 Arizona	E	Hermosa/Taylor	Ag, Pb, Zn	Arizona Mining Inc.	212 Moz Ag, 4.3 Mt Pb, 4.1 Mt Zn (D)
88 California	E	Castle Mountain	Au	Equinox Gold Corp.	4 Moz Au (D)
89 Nevada	E	Cove-McCoy	Au	Premier Gold Mines Ltd.	228,000 oz Au (ID)
90 Nevada	P	Marigold	Au	SSR Mining Inc.	2.7 Moz Au (R)
91 Nevada	E	Railroad	Au	Gold Standard Ventures Corp.	630,000 oz Au (D)
92 South Carolina	P	Haile	Au	OceanaGold Corp.	3.5 Moz Au (R)
93 Utah	E	Goldstrike	Au	Liberty Gold Corp.	865,000 oz Au (ID)
Rest of the World					
94 China	P	Ying	Ag, Au, Pb, Zn	Silvercorp Metals Inc.	95 Moz Ag, 27 koz Au, 460 kt Pb, 156 kt Zn (R)
95 Kazakhstan	P	Varvara	Au	Polymetal International plc	2.7 Moz Au, 300 koz Ag, 46 kt Cu (R)
96 Russia	P	Kupol	Au, Ag	Kinross Gold Corp.	1.7 Moz Au, 20 Moz Ag (R)
97 Russia	P	Pioneer	Au	Petropavlovsk plc	8.1 Moz Au (R)
98 Finland	P	Pahtavaara	Au	Rupert Resources Ltd.	76,000 oz Au (R)
99 Serbia	E	Timok	Cu, Au	Nevsun Resources Ltd.	1 Mt Cu, 2.2 Moz Au (D)
100 Sweden	E	Barsele	Au	Agnico Eagle Mines Ltd.	1.2 Moz Au (IF)

koz - thousand troy ounces; kt - thousand metric tons; Moz - million troy ounces; Mt - million metric tons; t - metric tons; oz — troy ounces.

Ag - silver; Au - gold; Co - cobalt; Cu - copper; K - Potash; Li - lithium; Ni - nickel; Pb - lead; Pd - palladium; Pt - platinum; Rh - rhodium; U - uranium; U₃O₈ - uranium oxide; Zn - zinc.

¹ D - Approved for development; E - Active exploration; F - Feasibility work ongoing/completed; P - Exploration at producing site.

² Resource estimate as of end of 2017 derived from various 2017 sources: D - measured + indicated; ID - indicated; IF - inferred; PR - probable; R - proven + probable.

Data were not verified by the U.S. Geological Survey. Where resource data were not released, the site was considered noteworthy by the authors based on the level of exploration activity or regional significance.

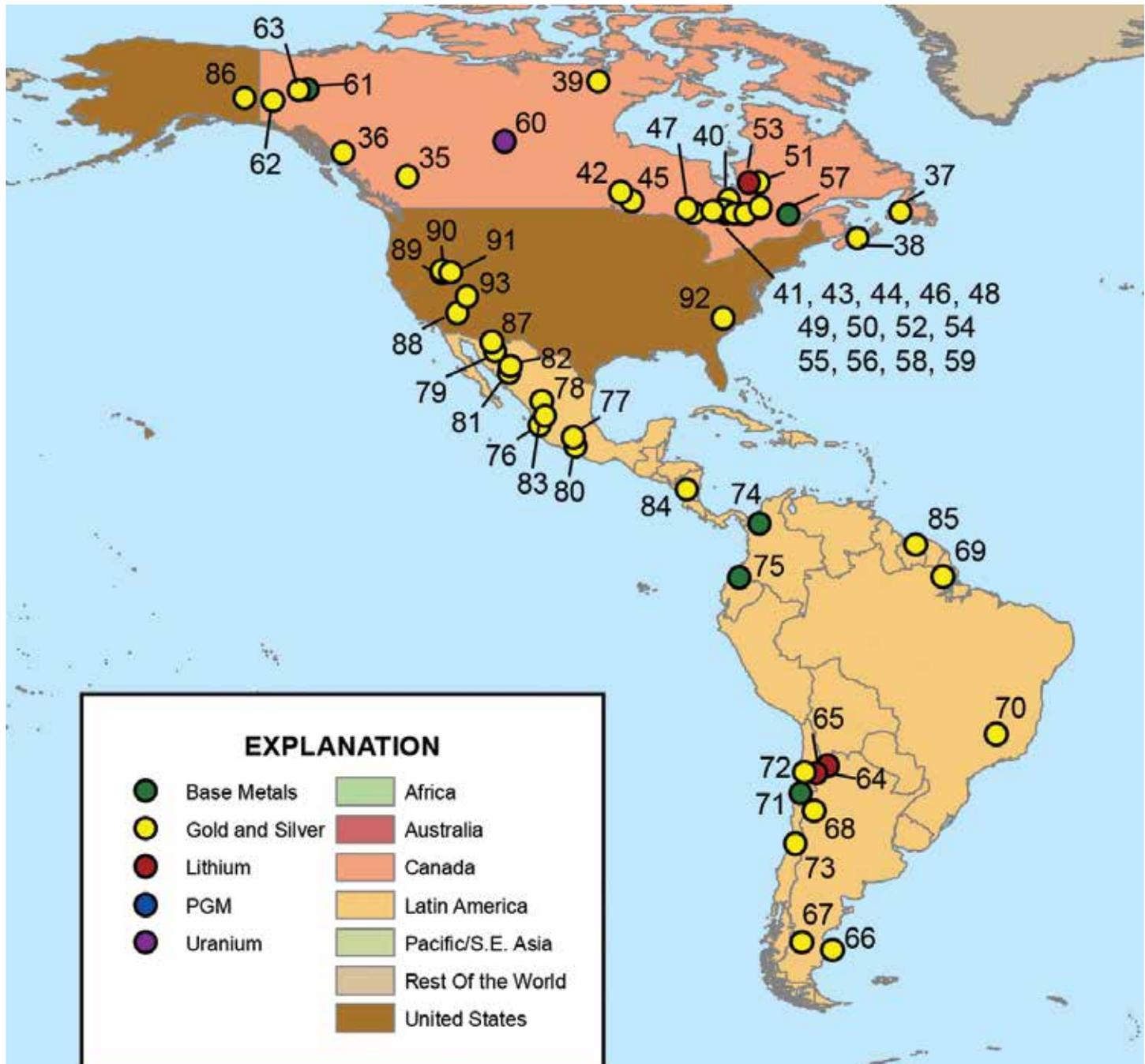
was used as the principal indicator, a site qualified if a 2017 budget of at least \$5 million was planned and executed for exploration and drilling activities. The criteria may eliminate early-stage projects for consideration where the level of drilling was below cutoff or development projects where

planned expenditures include costs for development or infrastructure.

- The high potential of near-term development, based upon reported tonnage and grade estimates derived from company announcements.
- The regional significance of an activity based on economic or social needs of

Figure 6

Regional exploration map showing the selected noteworthy sites for mineral exploration in 2017 by commodity.



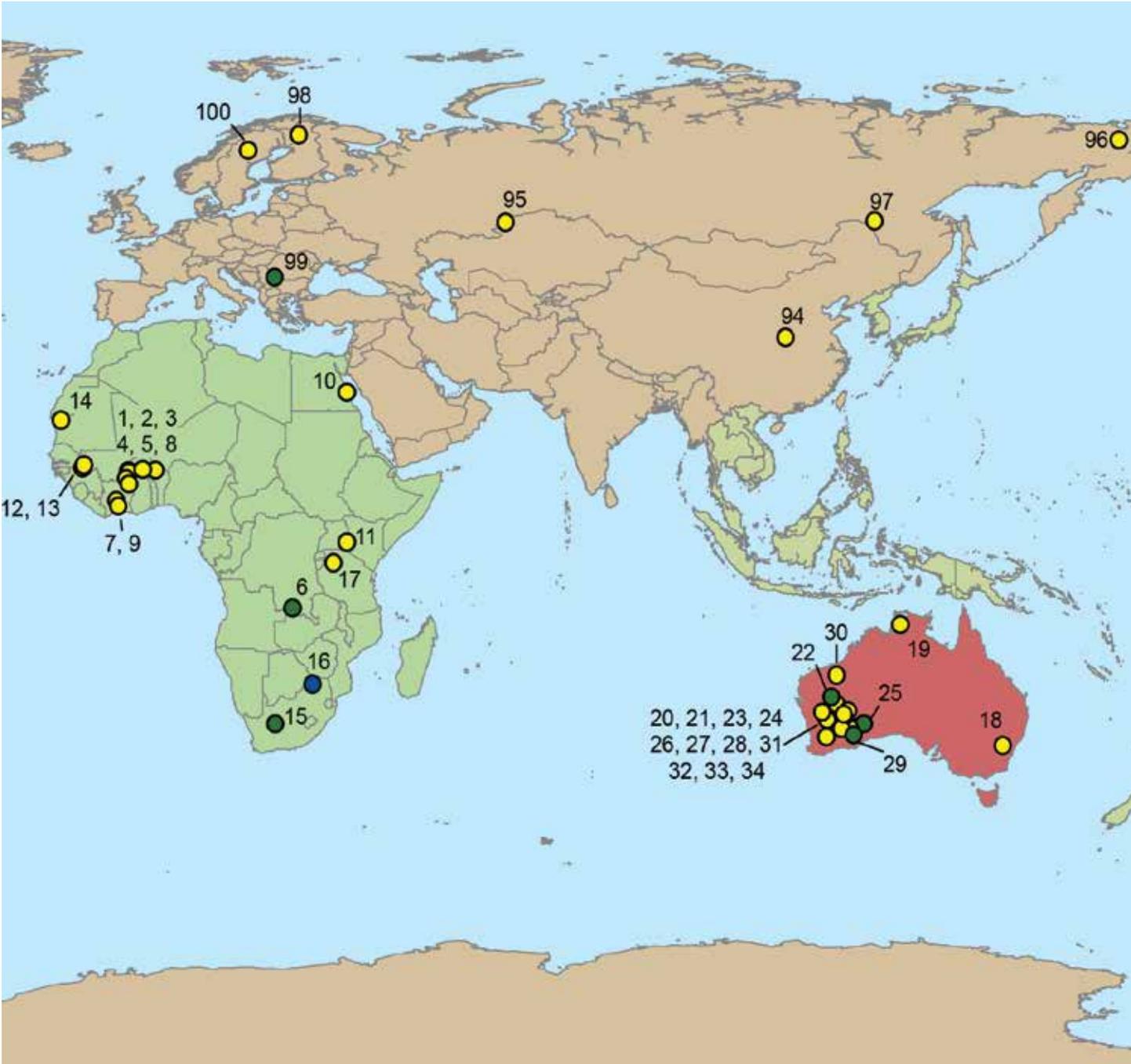
the locality.

- The project targets a new source of mineral supply that may be recoverable as a result of advances in extraction technology.

Sites where significant exploration activity and expenditures occurred prior to 2017 were

not included in Table 2 if the reported level of 2017 activity did not meet the selection criteria. Except where indicated, similar criteria have been applied to previous exploration summaries reported annually in the *USGS Minerals Yearbook* series and in exploration summary articles prepared by USGS staff and reported annually in *Mining Engineering*.

Figures reflect site numbers as shown in Table 2. Site data were compiled by the USGS based on published data and copyrighted data from SNL Metals & Mining, an offering of S&P Global Market Intelligence.



For 2017, gold continued to account for the greatest number of projects among the list of noteworthy exploration sites reported in Table 2. Of the sites selected for Table 2, the primary targets were: (1) gold or silver at 84 percent of the sites; (2) base metals at 11 percent of the sites; (3) lithium at 3 percent of the sites; (4) PGMs at 1 percent of the sites and (5) uranium at 1 percent of the sites. Determination of the primary commodity was based on consideration of commodity value of the contained resource at each site.

The estimated resources reported in Table 2 reflect various stages of verification, different methodologies and multiple sources of information based on company data. Should these reserves/resources be confirmed, however, they would contribute about 12 Mt (13.2 million st) of copper; about 11 Mt (12 million st) of lead and zinc; about 1.9 Mt (2.1 million st) of lithium; about 1.6 Mt (1.7 million st) of potash, expressed as potassium chloride; 428 kt (471,000 st) of nickel; 81 kt (89,000 st) of U_3O_8 ; 21 kt (677 million oz) of silver; 9 kt (10,000 st) of cobalt; 5.9 kt (191 million oz) of gold; 3.4 kt (3,700 st) of antimony; and 355 t (11 million oz) of PGMs to the identified world resources for these mineral commodities. It is likely, however, that only a portion of the listed resources may be converted to reserves as exploration continues.

Figure 6 shows the locations of the sites included in Table 2. Site numbers shown in Table 2 are reflected in Fig. 6 to allow the reader to identify each site. Sites have been classified by their primary commodity target.

The cost of doing business in a country can change based on many factors, including economic and environmental conditions, legislative actions, political activity and attitude and social receptivity to mining. These factors all determine the perceived risk profiles of a country. The Fraser Institute of British Columbia, Canada, annually publishes a survey assessing the effects of perceived investment attractiveness, which combines geologic attractiveness and the perceptions of public policy on attitudes toward exploration investment around the world. The 2017 survey (published Feb. 23, 2018) includes data from 360 respondent companies with an aggregated exploration budget of \$2.3 billion in 2017, up from \$1.9 billion in 2016.

According to the Fraser Institute survey, the top 10 destinations for mineral exploration based on overall investment attractiveness in 2017, listed in descending order, were Finland, Saskatchewan (Canada), Nevada (United

States), Ireland, Western Australia (Australia), Quebec (Canada), Ontario (Canada), Chile, Arizona (United States) and Alaska (United States). The top 10 destinations for mineral exploration based on their mineral potential independent of policy restrictions, listed in descending order, were Indonesia, Saskatchewan (Canada), Queensland (Australia), Western Australia (Australia), Alaska (United States), Finland, Chile, Nevada (United States), Ontario (Canada) and Quebec (Canada). The top 10 destinations for mineral exploration based solely on policy attractiveness, listed in descending order, were Ireland, Finland, Saskatchewan (Canada), Sweden, Nevada (United States), Northern Ireland, Michigan (United States), Wyoming (United States), Quebec (Canada) and Newfoundland and Labrador (Canada).

Exploration activity and related legislation by region

Exploration-related activities and events within each region are summarized below. The order of regional discussions are based on the amount budgeted for exploration in 2017 from highest to lowest. Areas not included in the regions discussed have been aggregated as Rest of the World and are discussed separately at the end of this section.

Latin America. Latin America continued its position as the leading destination for global exploration activity based on exploration budget data collected by SNL since 1994. Based on SNL data, the Latin America mineral exploration budget increased by about 20 percent to about \$2.4 billion in 2017 from \$2 billion in 2016, and represented about 30 percent of the estimated overall worldwide exploration budget for 2017. The exploration budget for Latin America in 2017 was 54 percent lower than its budget in 2012.

On the basis of data compiled for this review by the USGS, the top 10 Latin American countries with the greatest exploration site activity were Mexico (138 sites), Brazil (71), Argentina (57), Peru (53), Chile (49), Colombia (16), Ecuador (11), Bolivia (10), Guyana and Nicaragua (each 8). Latin America continued to be one of the leading regions for mineral exploration owing to its promising geology, its long history of world-class discoveries, the perception of its mineral policies and its successful historical record of mineral production and development.

Approximately 58 percent of the deposits actively explored in 2017 in Latin America

contained predominantly gold or silver, and 22 percent contained predominantly base metals, or some combination of precious and base metals, based on the sites considered in the USGS compilation. Activity in 2017 was used to further define early-stage discoveries (52 percent), conduct exploration at a producing site (30 percent), conduct prefeasibility and feasibility studies of economically promising prospects (12 percent), and further explore for resources of deposits under development (4 percent) or projects placed on care and maintenance (2 percent).

Based on SNL data, major companies accounted for the majority (71 percent) of the Latin American exploration budget, followed by junior companies (15 percent), intermediate companies (10 percent), and governments and other types of companies (4 percent). The budget share for major and intermediate companies increased from 2016 to 2017, while the budget share for junior companies and government entities decreased.

According to the 2017 Fraser Institute survey, Chile was the most attractive Latin American country for mining investment, overtaking Peru from the top ranking in 2016. Guatemala was listed last among Latin American countries. The data produced by the Fraser Institute correlates with the attractive investment climate rankings Business News Americas reports in its *Mining Survey 2017*, in which Peru and Chile were the top two countries in Latin America ranked on business investment.

Lithium demand is on the rise worldwide for its application in lithium-ion batteries that are used in electric vehicles and battery storage applications. Latin America is becoming an investor focus for this commodity particularly in the “lithium triangle” of Argentina, Bolivia and Chile. This region of Latin America is believed to host up to 70 percent of the world’s known lithium deposits located on the salt flats covering portions of all three countries. Of the Latin American countries, the lithium industry is most mature in Chile in terms of production and suitable infrastructure. However, private sector production of lithium has been restricted because the commodity has been declared strategic by the government. Bolivia is believed to host the largest lithium deposit in the world, but there are factors limiting exploration that include poor infrastructure, a challenging regulatory environment, resource nationalism and high taxes that are hindering investment. Many companies have conducted exploration activities in Argentina since the country opened

to foreign investment. Based on site data compiled by the USGS and the Geological Mining Service of Argentina, more than 30 companies undertook lithium exploration in 2017, and there are 53 lithium projects being explored in Argentina.

Since coming into office in January 2016, Argentina’s president has instituted changes in the mining industry, such as eliminating export taxes on precious and base metals and creating the Ministry of Energy and Mines in an effort to make Argentina more attractive for mining investment. In 2017, the national government and the governors of 20 provinces signed an agreement that would set a 3-percent ceiling on provincial royalties. Argentina’s National Glacier inventory was completed in 2017. This inventory is intended to provide a basis for legislation that would define areas that would be protected from future exploration and mineral development. Argentina and Chile agreed to update the common protocols that allow joint exploration of mineral resources along their common border.

Of the total exploration sites recorded by the USGS in Argentina, lithium (44 percent), gold/silver (42 percent) and copper (9 percent) were the leading mineral commodity targets in 2017. Greenfield stage projects were the highest (56 percent) in Argentina of all countries considered in the Latin America region.

Bolivian state mining company Corporación Minera de Bolivia (Comibol) announced plans to invest \$17 million in minerals exploration in 2017, using funds collected from mining royalties, as part of the government plan to invest up to \$2 billion in the mining and metallurgical industry by 2020. Bolivia’s Congress approved 117 mining contracts in 2017.

In Brazil, provisional measures that would establish new mining royalty rates, establish a mineral activity inspection tax and create a new national mining agency were approved by the Brazilian president and a congressional committee in 2017. The bill creating a national mining agency (entitled ANM) to manage the nation’s mining industry passed Congress and was signed into law in November. A bill increasing the iron ore royalty to 3.5 percent, gold royalty to 1.5 percent, niobium royalty to 3 percent and diamond royalty to 2 percent was signed into law in December 2017. An August decree that would open up a large part of the Amazon Basin to mineral development was subsequently revoked in September.

According to USGS data, exploration in Chile accounted for about 11 percent of

all exploration in Latin America. Copper represented 49 percent of all mineral commodities explored for, followed by gold at 29 percent, and a mixture of other commodities represented the remaining 22 percent.

According to government sources, there were 13,998 exploration permits issued in 2017, a decrease of about 24 percent from the number issued in 2016 and the lowest figure since 2007.

Chile's copper mining industry uses a large amount of freshwater and desalinated sea water, accounting for more than 70 percent of consumed water for mining operations in Chile. In 2017, water consumption by the copper industry increased by about 6 percent to 59.3 m³/sec, and energy consumption increased by about 1 percent. The growth in consumption is attributed to declining grades that require more ore to be processed to recover the same amount of copper; deeper pits of producing copper mines; and the depletion of surface oxide ores leading to a more energy intensive concentration process. Data compiled by BMI Research suggest that water scarcity and potential contamination likely will drive increasingly stringent environmental regulations in coming years.

Based on data reported by the Chilean Copper Commission (Cochilco), about half of the Chilean mining projects submitted for environmental evaluation between 2011 and 2016 were approved. Chile's environmental evaluation service (SEA) approved 227 of the 454 projects submitted during the five-year period. Another 31 percent of the projects remained under evaluation after five years.

Chile's geology and mining service launched a new platform that makes information on mineral exploration available to the public. Exploration companies are required to provide information on drilling, mapping, sampling and geophysical survey information for entry into this new system.

High electricity costs, low copper prices and falling grades are contributors to Chile's operating costs, which remained among the highest in the world. Although Chile is the world's leading producer of copper, data provided by Cochilco suggest that increased costs associated with water and energy consumption could affect future copper production in the country. Figures released by Cochilco suggest that water use between 2017 and 2028 is expected to increase by 40 percent and energy use is expected to increase by 38 percent, as more Chilean copper mines recover copper by energy intensive concentration methods rather than more energy efficient

solvent extraction and electrowinning (SX-EW) methods. Cochilco figures indicate that SX-EW processing represented 30 percent of Chile's mined copper in 2017 and will account for less than 9 percent by 2028 as surface oxide ores are depleted.

A number of municipalities in Colombia voted to ban mining in their jurisdictions. The vote in the Tolima province resulted in the suspension of activities at AngloGold's La Colosa gold mine. As of May 2017, 39 referendums were planned, and as of July 2017, seven areas had rejected mineral exploration and development. Regional concerns increased following the recent reduction of mining royalties from 70 percent to 9 percent, as municipalities expressed concern about environmental effects of mining in light of an anticipated loss of revenue from mining activity.

In August 2017, the Dominican Republic suspended the granting of new mining exploration permits for 90 days and exploration concession permits for six months to allow time for an overhaul of existing regulations. Since then, a draft mining code has been developed by the Energy and Mines Ministry that includes provisions that would provide the state with at least 40 percent of mining income based on a combination of income tax, license fees and royalties.

In recent years, interest and investment in Ecuador's mining sector increased as a result of revised regulations, significant gold and copper resources and an expanded marketing campaign. During the first half of 2017, Ecuador awarded 233 new exploration concessions, about 80 percent of which were awarded to Australian and Canadian companies. Ecuador's president introduced a series of economic measures in October, including tax breaks and a streamlined permitting process. At yearend, these measures still needed to be approved by the Ecuadorian Congress.

A law was passed in El Salvador that bans all exploration, extraction and processing of metals and the use of cyanide and mercury in nonmetallic mineral processing. El Salvador would be the first country to impose such a broad restriction on the extraction of minerals.

Budget data suggest that metals exploration in Mexico was expected to increase to \$650 million in 2017 from \$467 million in 2016, based on data reported by Cámara Minera de México (Camimex). Companies with operating mines in Mexico recently acquired minority positions in junior companies with early-stage projects in the region. During 2017, three special economic

zones were created, allowing for enhanced tax incentives for investment, workforce training, and the creation of infrastructure. Several bills were introduced in the legislature to reform the tax structure and environmental controls related to mining.

Nicaragua's National Assembly approved the creation of a state mining company, Empresa Nicaragüense de Minas (Eniminas), which will represent the state in mining concession negotiation and be involved in mineral exploration, mining activities, and forming alliances with other mining and exploration firms.

Peru's government issued a resolution intended to ease mining regulations by exempting most small-scale exploration projects from the national system of environmental evaluation. Government data reported a total of \$891 million in mining exploration commitments in 2017. Exploration expenditures in Peru during the first half of 2017 increased 28 percent to \$152 million, compared with the same period in 2016.

A new port at Nueva Palmira designed to ship 9.1 kt/a (10 million stpy) of minerals from Uruguay was opened in 2017.

Canada. Statistics as of September 2017 released by Natural Resources Canada (NRC) show 2017 revised spending intentions at C\$2 billion (US\$1.5 billion), up about 23 percent from an actual expenditure of C\$1.6 billion (US\$1.3 billion) for 2016. Based on SNL data, Canadian mineral exploration increased by about 12 percent to about US\$1.1 billion in 2017 from US\$986 million in 2016, representing about 14 percent of the estimated overall worldwide exploration budget for 2017. NRC statistics include planned exploration expenditures for a wider variety of minerals than were included in the SNL estimates.

As of September 2017, the revised exploration and deposit appraisal budget for precious metals was C\$1.3 billion (US\$988 million); base metals, C\$274 million (US\$212 million); uranium, C\$125 million (US\$97 million); diamond, C\$60 million (US\$47 million) and iron ore, C\$21 million (US\$16 million) of the C\$2 billion (US\$1.5 billion) exploration total, according to NRC. When the NRC exploration statistics were reconfigured to make them comparable with SNL statistics, the reported total exploration expenditure was C\$1.8 billion (US\$1.4 billion). The data suggest that the revised budgets for precious metals deposits increased significantly from the initial budgets proposed for 2017. Company

exploration spending for 2017 as reported by NRC as of September 2017 was greatest in Quebec (27 percent of the total exploration and deposit appraisal spending intentions for Canada), Ontario (25.6 percent), British Columbia (14.1 percent), Saskatchewan (9.1 percent), Nunavut (7.8 percent), Yukon Territory (6.7 percent), Northwest Territories (3.5 percent), Manitoba (2.3 percent), Newfoundland and Labrador (1.7 percent), Alberta (1.3 percent), New Brunswick (0.7 percent) and Nova Scotia (0.2 percent).

Canadian provinces with the largest increases in exploration activity in 2017 from 2016, based on reported budget allocations from NRC, were Quebec, with an 81 percent increase, primarily for increased base and precious metals exploration; Alberta, 56 percent, primarily for increased exploration for precious metals, iron ore and other minerals; the Yukon Territory, 48 percent, primarily for increased exploration for precious metals; Newfoundland and Labrador, 35 percent, primarily for increased exploration for base and precious metals and Ontario, 30 percent, primarily for precious metals. Canadian provinces with the largest decrease in exploration activity in 2017 from 2016, based on NRC reported budget allocations, were Nunavut, with a 23-percent decrease, primarily from decreased exploration for base and precious metals and iron ore and Saskatchewan, 21 percent, primarily from decreased exploration for uranium and other minerals.

According to NRC, major exploration companies accounted for about 48 percent of Canadian exploration spending intentions in 2017, down from about 61 percent in 2016. Junior companies were apparently able to secure a greater amount of financing in 2017 than in 2016, and accounted for about 52 percent of the Canadian exploration expenditure in 2017. In terms of mineral commodities sought country-wide in 2017, precious metals were the primary focus of exploration spending intentions (64 percent, up from 58 percent in 2016), followed by base metals (14 percent, down from 15 percent), and uranium (6 percent, down from 10 percent). Nonmetals, other metals, diamond and iron ore together accounted for 13 percent of the Canadian mineral exploration budget in 2017.

On the basis of data compiled for this review by the USGS, Quebec was the leading province for exploration activity in 2017 (146 sites), followed by Ontario (114), British Columbia (96), Saskatchewan (38), Yukon

Territory (37), Manitoba (22), Nunavut (21), Newfoundland and Labrador (19), New Brunswick (15), Northwest Territories (14), Nova Scotia (7) and Alberta (3).

Approximately 57 percent of the deposits actively explored in Canada during 2017 contained predominantly gold or silver, 20 percent base metals, 4 percent uranium, 3 percent diamond, 2 percent PGMs, 1 percent iron ore and the remainder contained other mineral commodity targets, based on the sites considered in the USGS compilation. Activity in 2017 was used to further define early-stage discoveries (77 percent), conduct exploration at a producing site (12 percent), conduct prefeasibility and feasibility studies of economically promising prospects (8 percent), further explore for resources of deposits under development (2 percent) or projects were placed on care and maintenance (1 percent).

As part of its 2017 budget, the Canadian government extended its 15 percent Mineral Exploration Tax Credit through March 31, 2018. The tax credit has been in effect since 2000. The government also announced plans to launch the Trade and Transportation Corridors Initiative by allocating C\$400 million (US\$310 million) in dedicated funding for transportation infrastructure in Northern Canada.

The British Columbia provincial government continued its Mining Exploration Tax Credit through Jan. 1, 2020 and extended the provincial Mining Flow-Through Share Tax Credit through Dec. 31, 2017. The province amended the Income Tax Act to make environmental studies and community consultations eligible for British Columbia's Mining Exploration Tax Credit. The provincial Government allocated an additional C\$10 million (US\$7.7 million) in funding to support the work of Geoscience BC, which launched a third phase of aerial geophysical surveys over northern British Columbia in 2017.

The government of the Northwest Territories allocated about C\$1 million (US\$770,000) to stimulate mineral exploration in the province. The funding was shared between seven companies and six prospectors for projects exploring for diamond, gold, lithium and zinc. Yukon Territories operate a similar program that allocated C\$1.6 million (US\$1.2 million) in 2017 for mineral exploration activities on 59 projects.

The Ontario Ministry of Northern Development and Mines announced a fourth round of funding for the Junior Exploration Assistance Program, which provides rebates to junior exploration companies for early-

stage exploration to a maximum of C\$100,000 (US\$77,000) per project. Following several years of negotiations and delays, the Ontario provincial government announced that it would support and fund road proposals that would provide all-season access to both First Nations communities and the Ring of Fire mining district.

The Yukon Geological Survey estimated that mineral exploration spending in the province in 2017 could reach C\$120 million (US\$93 million) in 2017, compared to C\$57 million (US\$44 million) in 2016. These values are similar to those reported by NRC.

The Fraser Institute report, *Permit Times for Mining Exploration* in 2016, showed that the length of time required to issue exploration permits in Canada continues to increase. According to the report, 73 percent of respondents said that permit times had stayed the same in Saskatchewan while respondents from all other provinces/territories reported lengthened permit times with Yukon being the extreme of 70 percent.

Africa. Based on SNL data, the Africa mineral exploration budget increased by about 18 percent to about \$1.1 billion in 2017 from \$900 million in 2016, representing about 14 percent of the estimated overall worldwide exploration budget for 2017. On the basis of data compiled for this review by the USGS, the top 12 African countries with the greatest exploration site activity were South Africa (44 sites), Burkina Faso (32), the Democratic Republic of the Congo (DRC) (29), Tanzania (23), Mali (22), Ghana (17), Côte d'Ivoire (11), Namibia (11), Botswana (10), and Guinea, Senegal and Zimbabwe (7 each).

Approximately 50 percent of the deposits actively explored in 2017 in Africa contained predominantly gold or silver, 15 percent contained predominantly base metals, 7 percent contained diamond, 5 percent contained PGMs, 3 percent contained uranium, 2 percent contained iron ore, and 18 percent of the exploration sites contained other minerals, primarily graphite, heavy minerals, lithium, phosphate, potash and REEs, based on the sites considered in the USGS compilation. Activity in 2017 was used to further define early-stage discoveries (46 percent), conduct exploration at a producing site (31 percent), conduct prefeasibility and feasibility studies of economically promising prospects (14 percent), further explore for resources of deposits under development (7 percent) or projects were placed on care and maintenance (2 percent).

Based on SNL data, major companies accounted for the greatest share (51 percent) of the Africa exploration budget, followed by junior companies (30 percent), intermediate companies (15 percent), and governments and other entities (4 percent). Exploration by junior companies increased by 36 percent, and exploration by major companies increased by 28 percent from 2016 to 2017.

Between 2012 and 2016, mineral exploration in Africa declined in terms of exploration budget and number of active sites. According to SNL, the Africa mineral exploration budget decreased 73 percent in 2016 from the most recent peak in 2012. However, the African exploration budget increased about 18 percent from 2016 to 2017. Similarly, the number of active exploration sites in Africa monitored by the USGS decreased about 41 percent from 2012 to 2016. The number of active exploration sites in Africa remained stable between 2016 and 2017. According to a study by BMI Research, Sub-Saharan Africa remains one of the riskiest areas of the world for mineral development because of policy uncertainty, political risk and underdeveloped infrastructure. Other challenges include concerns about conflict minerals, illegal mining, armed conflicts, regulatory uncertainty and accountability and resource nationalism favoring an increase in mineral rents and mining taxes in some African countries.

Since the government of China launched its “Two Resources, Two Markets” program in 2006, China’s investment in the mining sector of Africa has grown. In 2017, Ghana signed a \$10 billion deal with China to provide funding for the development of infrastructure necessary for the exploration and development of the bauxite mining industry in Ghana.

After two years of testing, the Just Gold project reached an implementation stage in the DRC. The project developed a system for tracing legal and conflict-free artisanal gold in the Great Lakes region, intended to reduce the flow of conflict minerals. This is necessary if production of conflict-free cobalt from the DRC, the world’s largest supplier, is to increase in response to increased demand for cobalt to supply the growing electric vehicle market. Although the supply of conflict minerals from this region of Africa may decrease because of these actions and increased diligence by governments and NGOs, a 2017 report released by Verisk Maplecroft suggests that African countries in the Great Lakes region may no longer be the largest source of conflict minerals. Gold, tin and tungsten production have been

traced to armed groups in Colombia and Myanmar.

Illegal artisanal gold mining is a problem in Burkina Faso, Côte d’Ivoire and Mali, according to a 2017 report by Partnership Africa Canada. An investigation conducted by the organization found that all three countries have taken steps to reduce illegal trade of artisanal gold, but Mali’s application of export taxes to only the first 50 kg/m (1,763 oz/month) of gold is actually promoting smuggling, as traders that bring gold over the border into Mali get a large tax break.

The DeBeers Group has launched the world’s largest diamond exploration ship to explore and mine diamonds off the coast of Namibia. The ship, joining DeBeers’ existing fleet of five ships, has the capacity to hunt for diamonds at more than twice the speed of its predecessors.

As DeBeers diamond exploration activities in Namibia increase, its exploration program in South Africa has been limited as a result of ongoing legislative issues and delays in issuing up to 54 prospecting licenses by South Africa’s Department of Minerals Resources (DMR). South Africa’s mining industry continued to face a number of challenges, including aging infrastructure and technology, energy shortages, labor instability and regulatory uncertainty. The South African DMR promulgated a new version of the Mining Charter in June 2017 that increased black economic empowerment (BEE) shareholding and required that 70 percent of all goods and 80 percent of all services be provided by BEE entities, leading the South African Chamber of Mines to oppose the new legislation. In August 2017, however, an agreement was reached between the DMR and the Chamber of Mines that would place a temporary moratorium on the enactment of the legislation.

In March 2017, the Tanzanian government passed a directive banning the export of gold and copper concentrate. In July, the Tanzanian Parliament passed three laws that 1) require the government to own at least a 16-percent stake in mining projects; 2) increase royalties on copper, gold, platinum and silver exports; and 3) suspend the issuing of new mining licenses.

Australia. Based on SNL data, the Australia mineral exploration budget increased by about 19 percent to about \$1.1 billion in 2017 from \$900 million in 2016, representing about 14 percent of the estimated overall worldwide exploration budget for 2017. The Australian

Bureau of Statistics (ABS) reported expected mineral exploration expenditures (including coal and excluding petroleum) for its fiscal year from July 2016 through June 2017 of about A\$1.6 billion (US\$1.2 billion), a 10 percent increase from the actual Australian expenditure for fiscal year 2015-2016 of A\$1.4 billion (US\$1 billion). According to ABS, Western Australia accounted for 66 percent of the Australian mineral exploration expenditure in 2016-2017; Queensland accounted for about 13 percent; New South Wales accounted for about 9 percent; Northern Territory, about 5 percent; South Australia and Victoria, about 3 percent each and Tasmania, about 1 percent. ABS reported that exploration expenditures increased in Victoria by 41 percent from 2015-2016 to 2016-2017, primarily because of an increase in gold exploration. Exploration expenditures in Western Australia increased by 18 percent, primarily because of an increase in the exploration expenditure for gold and base metals. Exploration expenditures in New South Wales increased by 17 percent, primarily because of increases in the exploration expenditure for gold. Exploration expenditures decreased by 22 percent in Northern Territory, primarily owing to a decrease in exploration for gold and uranium. Exploration expenditures decreased about 11 percent in Queensland, primarily due to a decrease in coal exploration. Exploration in South Australia and Tasmania remained relatively stable from 2015-2016 to 2016-2017.

Of the total nonfuel Australian expenditure for metals and minerals during Australia's fiscal year of 2016-2017 reported by ABS, the gold exploration expenditure accounted for about 48 percent of the total; iron ore accounted for about 20 percent; base metals accounted for about 19 percent; other minerals accounted for about 10 percent; and uranium, heavy minerals and diamond together accounted for about 3 percent. The expenditure for nickel-cobalt deposits increased 59 percent from 2015-2016 to 2016-2017. The expenditure for other minerals (driven largely by demand for lithium) increased about 29 percent, and the expenditure for gold deposits increased about 26 percent. Conversely, the expenditure for diamond exploration decreased about 60 percent and the expenditure for uranium exploration decreased 44 percent. ABS data suggest that new deposits accounted for about 31 percent of the total exploration budget for Australia in 2016-2017, compared to 29 percent in 2015-2016.

In terms of number of meters drilled for

mineral exploration, the ABS reported that about 7.5 million m (24.6 million ft) were drilled in 2016-2017 and 6.4 million m (21 million ft) were drilled in 2015-2016, an increase of 19 percent. The Western Australia Department of Mines and Petroleum reported that the number of exploration licenses for minerals and coal in Western Australia increased by about 11 percent from 2015-2016 to 2016-2017, while the area covered by these licenses increased 13 percent. The ABS statistics include expenditures for coal and industrial minerals that were not included in the SNL statistics.

On the basis of data compiled for this review by the USGS, the ranking of Australian states with the greatest number of exploration sites in 2017 were Western Australia (319), Queensland (53), New South Wales (50), Northern Territory (35), South Australia (26), Victoria (16) and Tasmania (5). Activity in 2017 was used to further define early-stage discoveries (61 percent), conduct exploration at a producing site (21 percent), conduct prefeasibility and feasibility studies of economically promising prospects (10 percent), further explore for resources of deposits under development (5 percent) or projects were placed on care and maintenance (3 percent).

Based on SNL data, junior companies accounted for the majority (42 percent) of the Australia exploration budget, followed by major companies (34 percent), intermediate companies (22 percent), and governments and other types of companies (2 percent). The exploration share for intermediate companies increased about 42 percent between 2016 and 2017, the share for junior companies increased about 27 percent, and the share for major companies increased about 3 percent. The data suggest that junior companies were better able to secure financing for Australian exploration projects in 2017 than in 2016, and merger and acquisition activity increased, creating more intermediate-size companies.

The fiscal year 2017-2018 government operating budget for Australia did not include provisions to extend the Exploration Development Incentive Program in its current form. The government announced plans to fund a new A\$100-million (US\$80-million) Junior Mineral Exploration Tax Credit to stimulate mineral exploration investment. In 2017, the federal government planned to invest about A\$20 million (US\$15 million) in the Pilgangoora lithium tantalum project through its Clean Energy Finance Corp. as a means of indicating its support to develop an Australian supply chain for renewable energy storage, electric vehicles,

and other clean energy initiatives.

As part of its 2017-2018 budget, the Queensland government set aside A\$27 million (US\$20 million) to fund mineral exploration activities in the state's northwest region over four years. This effort is part of a newly released exploration blueprint for developing the resources of the North West Minerals Province.

The Victorian government set aside a further A\$1.2 million (US\$900,000) in funding for new projects exploring for gold in northern Victoria. This is the second round in the Government's A\$15 million (US\$11 million) Target Grants Program. The government is planning to open up new areas in the Stavelly province for minerals exploration by tender. The area is reported to contain significant copper resources.

The Western Australia government committed A\$4.75 million (US\$3.7 million) in round 14 and A\$5.26 million (US\$4 million) in round 15 of its Exploration Incentive Scheme (EIS) in 2017. The EIS is a competitive program that offers up to a 50-percent refund for selected exploration drilling projects. The Western Australian Department of Mines, Industry Regulation, and Safety received 2,575 Programme of Work applications in calendar year 2017, compared to 1,799 in calendar year 2016. The Western Australia government banned future uranium mining in the state, but plans to allow four projects that have already received approval to proceed. The Supreme Court of Western Australia delivered a ruling in 2017 that would make it easier for tenement holders to get an exemption from exploration expenditure obligations.

United States. Based on SNL data, the United States mineral exploration budget increased by about 19 percent to about \$611 million in 2017 from \$512 million in 2016, representing about 8 percent of the estimated overall worldwide exploration budget for 2017. In 2016, Nevada was reported to have the largest exploration budget, accounting for about 47 percent of the SNL exploration budget for the United States. The budget for Alaska accounted for about 17 percent of the U.S. budget and the budget for Arizona exploration activities accounted for about 9 percent of the U.S. budget. Data were collected on 225 active exploration projects for this review by the USGS. The U.S. states with the greatest number of exploration sites were Nevada (92), Alaska (32), Arizona (24), Idaho (14), California (8), Colorado (8), Montana (8), Utah (8) and Wyoming (7). Most of these sites

had prior exploration activity, suggesting that economic conditions were such that exploration companies continued prior exploration activity or re-evaluated sites because of technological advancements or their proximity to recent discoveries or deposits with similar geology. SNL data suggest that exploration drilling in the United States increased by about 43 percent in 2017 from the level in 2016, based on the number of holes drilled.

Approximately 54 percent of the deposits actively explored in 2017 in the United States contained predominantly gold or silver, 22 percent contained predominantly base metals (primarily copper) and 4 percent contained uranium. Approximately 20 percent of the active exploration sites in the United States had other mineral targets. A large percentage were seeking lithium, cobalt and tungsten deposits based on the sites considered in the USGS compilation. Activity in 2017 was used to further define early stage discoveries (69 percent), conduct exploration at a producing site (19 percent), conduct prefeasibility and feasibility studies of economically promising prospects (9 percent), further explore for resources of deposits under development (2 percent), or were placed on care and maintenance for various reasons (about 1 percent).

Based on SNL data, major companies accounted for the majority (61 percent) of the U.S. exploration budget, followed by junior companies (34 percent), and intermediate companies, government entities, and other types of companies (a combined 5 percent). Junior companies increased their share of the U.S. exploration budget in 2017 more than other company types.

The Nevada Bureau of Mines and Geology (NBMG) reported that the exploration budget for minerals in Nevada for 2017 was expected to be greater than the 2016 budget of \$325 million. According to the 2016 NBMG survey released in March 2017, 51 percent of the respondents indicated they would be spending more for exploration in 2017 than they did in 2016, and 37 percent indicated that they would be spending at about the same level as 2016. The number of active mining claims in Nevada increased in 2017 to 178,176 from the 163,542 claims documented in 2016. Gold exploration accounted for about 86 percent of the 2016 exploration budget, and exploration for lithium showed a steady increase between 2011 and 2016, accounting for about 6 percent of the reported exploration activity in Nevada in 2016. In mid-July 2017, there were 13,381 claims for lithium-targeted deposits filed with the U.S. Bureau of Land Management in

Nevada by 26 companies.

Based on the number of active exploration sites reviewed by the USGS, exploration for gold and silver in Nevada represented about 68 percent of projected mineral exploration activity in the state. While the principal mineral exploration targets in Nevada continued to be gold and silver, exploration activity for lithium in recent years has increased significantly (there were seven active sites in 2015 and 27 active sites in 2017).

Based on a 2017 report released by the Alaska Department of Natural Resources, Alaskan exploration expenditures increased slightly to about \$58.9 million in 2016 from \$58.3 million spent in 2015, and Alaskan mineral development expenditures decreased 30 percent to about \$217 million in 2016 from about \$310 million spent in 2015. About 49 percent of the state's exploration spending in 2016 was conducted in areas adjacent to major mines. About 29 percent of the total estimated exploration expenditure for 2016 was spent exploring for gold veins, 33 percent for massive sulfide deposits, 21 percent for porphyry deposits and 15 percent for intrusive gold deposits. About 43 percent of the total expenditure was for polymetallic deposits, 42 percent for precious metals, 13 percent for base metals and 2 percent for other minerals. In 2016, 5,656 federal and 31,221 state mining claims were active. Actual data for 2017 were unavailable, although the exploration expenditures in Alaska were thought to be higher than the \$59 million expended in 2016.

The U.S. Environmental Protection Agency announced its intention to withdraw proposed Clean Water Act restrictions on the development of the Pebble copper-gold deposit as part of its May 2017 settlement agreement with the Pebble Land Partnership. Public hearings on the proposal were conducted in 2017. This decision was reversed in early 2018.

The USGS, in conjunction with the Alaska Division of Geological & Geophysical Surveys, conducted hyperspectral surveys and evaluated the mineral potential for REEs, placer and paleo-placer gold, PGMs, carbonate-hosted copper, sandstone uranium, and tin-tungsten-molybdenum-fluorspar deposits throughout the state.

The U.S. Department of the Interior announced plans to speed up the approval of a 20-year ban on gold mining claims on more than 30,000 acres in Montana north of Yellowstone National Park. The U.S. House of Representatives passed a bill to reopen Superior National Forest land near the Boundary Waters Wilderness Area

in Minnesota to mineral exploration. In Michigan, legislation enacted in May 2017 would establish separate regulations for small native copper mines from regulations applicable to larger mines.

Wisconsin Gov. Scott Walker signed a bill lifting regulations put in place in 1998 restricting gold and silver mining in the state. Since passage of these regulations, the Wisconsin Department of Natural Resources has never issued a final decision that any mine had met these requirements.

Pacific/S.E. Asia. Based on SNL data, the Pacific and Southeast Asia region (excluding Australia) mineral exploration budget decreased by about 18 percent to about \$300 million in 2017 from \$370 million in 2016. This region accounted for about 4 percent of the estimated overall worldwide exploration budget for 2017. Indonesia, Papua New Guinea and the Philippines together accounted for about 76 percent of the total mineral exploration budget for the region, predominantly targeting base metals (50 percent) and gold (47 percent). On the basis of data compiled for this review by the USGS, the top 10 Pacific/S.E. Asian countries with the greatest number of exploration sites were Papua New Guinea (14), Indonesia (13), Philippines (10), the Republic of Korea (9), New Zealand (6), Cambodia (5), Thailand (4), Burma (Myanmar), Fiji and New Caledonia (3 each). Indonesia, the Philippines and Papua New Guinea together accounted for about 50 percent of the active exploration sites in the region in 2017.

Approximately 44 percent of the deposits actively explored in 2017 in the Pacific/S.E. Asia region targeted gold, 37 percent targeted base metals, 4 percent targeted iron ore and 15 percent targeted other minerals. Activity in 2017 was used to further define early-stage discoveries (51 percent), conduct exploration at a producing site (28 percent), conduct prefeasibility and feasibility studies of economically promising prospects (13 percent), further explore for resources of deposits under development (4 percent) or projects were temporarily suspended (4 percent).

Based on SNL data, major companies accounted for the majority (59 percent) of the Pacific/S.E. Asia exploration budget, followed by junior companies (22 percent), intermediate companies (11 percent) and governments and other types of companies (8 percent). Majors were the only company type that increased in share from 2016 to 2017, all other company types declined.

Interest in this region can be attributed to

interest by Chinese and Korean companies to expand sources of supply for gold, base metals and REEs from nearby countries; Japanese companies interested in developing regional copper and nickel deposits to supply Japan's smelting industry; and interest by neighboring countries in reducing the effects of the Indonesia ban on unprocessed mineral exports by developing their own indigenous sources. The reduced growth of portions of the Chinese minerals industry in recent years has slowed mineral exploration in the Pacific/S.E. Asia region. Since its peak in 2012, exploration expenditure in the region has decreased 78 percent and the number of active sites has declined by 53 percent.

Indonesia eased its mineral export ban implemented in 2014, that banned exports of unprocessed minerals and forced mining companies to construct value-added smelters in the country. The ban, scheduled to come into effect in January 2017, was modified to allow the export of nickel ore and bauxite as long as progress is shown toward building downstream smelters within a five-year period. The regulatory uncertainty in Indonesia contributed to the decision by Newmont Mining to sell its gold assets in Indonesia. De Long Nickel Co. Limited has put expansion plans in the country on hold, and PT Vale Indonesia Tbk has found it more difficult to secure partnerships for planned nickel projects.

Malaysia implemented a moratorium on bauxite mining in 2016 and extended the ban until the end of 2017 in order to allow the export of bauxite stockpiles at the port of Kuantan. As of mid-2017, the stockpiles were reported to be no smaller than they were at the start of the ban 18 months prior, even as Malaysia has exported more than 9 Mt (10 million st) of bauxite to China. Unregulated miners are attempting to fill the gap left by bauxite export bans in Indonesia and the Philippines.

The autonomous Bougainville region of Papua New Guinea lifted a ban on mining and exploration in the iron-rich areas of Tore, Isina and Jaba. The ban on the copper-rich Panguna region was not lifted, however.

Since the 2016 Philippine presidential election, an audit of the country's mines was implemented. In 2017, the government continued to suspend the operating permits of mines alleged to contribute to environmental degradation. In February, the government ordered the closure of 23 mines, including nickel producers that accounted for about half of the country's nickel production, canceled 75 mining

exploration contracts, and banned mining in watershed zones. In April, the Philippines Natural Resources Minister announced a ban on future openpit mining.

Rest of the World. Based on SNL data, the regional mineral exploration budget for the Rest of the World increased by about 9 percent to about \$1.4 billion in 2017 from \$1.3 billion in 2016. The budget for this region represents about 17 percent of the estimated overall worldwide exploration budget for 2017. Exploration in China and Russia accounted for about 52 percent of the exploration budget for countries in Asia, the Commonwealth of Independent States (CIS), Europe and the Middle East in 2017. China accounted for about 5 percent of the global exploration budget in 2017 and Russia accounted for about 4 percent. On the basis of data compiled for this review by the USGS, the ROW countries with the greatest number of exploration sites were Russia (55), China (24), Sweden (20), Finland (19), Mongolia and Turkey (12 sites each), Spain (11), Greenland and Portugal (9 sites each), and Kazakhstan and Serbia (8 sites each).

Approximately 50 percent of the deposits actively explored during 2017 in the ROW region contained gold or silver, 25 percent contained base metals, 4 percent contained iron ore and 21 percent contained other minerals, based on the sites considered in the USGS compilation. Selected regions within the ROW reported exploration activity as follows: Asia, primarily China, focused on gold and silver (40 percent), base metals (38 percent) and other minerals (22 percent). Exploration in the CIS focused on gold or silver (72 percent) base metals (11 percent) and other minerals (17 percent). European mineral exploration primarily focused on gold (42 percent), base metals (28 percent) and other minerals (30 percent). Middle Eastern exploration primarily focused on gold (33 percent), base metals (33 percent) and other minerals (34 percent). Activity in 2017 of the composite region was primarily used to further define early stage discoveries (47 percent), conduct exploration at producing sites (36 percent), conduct prefeasibility and feasibility studies of economically promising prospects (10 percent), and further explore for resources of deposits under development (6 percent). About 1 percent of the sites were reported to be on care and maintenance.

Based on SNL data, major companies accounted for the majority (54 percent) of the ROW exploration budget, followed by

junior companies (15 percent), intermediate companies (11 percent), and governments and other types of companies (20 percent).

In spite of its slower growth in recent years, China continues to be a key player in mineral exploration and development. Price Waterhouse Coopers listed 12 Chinese companies in its 2016 top 40 mining groups. Total overseas assets held by China's centrally owned enterprises were expected to reach \$900 billion in 2017, with investments in more than 185 countries and regions. For example, China invested A\$865 million (US\$650 million) in Australian mining projects in 2016, particularly in gold and lithium. Chinese mining companies are seeing a number of their foreign investment deals being delayed because of the difficulty in obtaining regulatory permission to purchase the foreign exchange needed to close deals. Since December 2016, four out of a total of 23 foreign investment deals have been terminated. Exploration in China continues, primarily by major companies and government entities. In 2017, discoveries of large gold and manganese deposits were reported.

After three years of debate, the European Union passed legislation that requires all 28 member countries to identify their sources of metal and mineral imports and ensure that their supply chains do not contribute to funding armed conflict. The legislation becomes binding in January 2021.

The government of Greenland amended licensing agreements for holders of minerals exploration licenses, which would reduce the expenditure obligations such that the licensee would not be obligated to pay fees in the sixth through the 11th years of the license.

The mineral exploration budget for India increased about 28 percent in 2017 from its 2016 level. Although modest by world standards, several legislative efforts were approved in 2016-2017 designed to stimulate mineral exploration. The National Minerals Exploration Policy (NMEP) was approved in 2016, which allows private companies to bid on mineral exploration blocks put up for auction by the government. In the first auction, the government received bids on 29 of the 50 blocks put up for auction. Lack of enabling provisions and restrictive conditions in the NMEP appear to be keeping some foreign mining companies from participating. In order to stimulate interest, the Mines Ministry has invited 30-40 junior mining companies to submit proposals for private-public-partnership contracts, and allowed mineral development in coastal areas and extended the auction process to offshore mineral blocks. For the fiscal year 2017-2018, 71 mineral blocks are planned for auction.

The government increased the gold tax rate from 2-2.5 percent to 3 percent, effective July 1, 2017.

After the United States and other countries imposed new sanctions on Iran in 2017, Iran suspended almost all of its mining agreements with foreign investors. Less than \$100 million of these projects are progressing, compared with the estimated \$50 billion in potential investment the government was seeking from overseas mining companies by 2022.

The government of Luxembourg passed a law that defines the conditions companies must fulfill to obtain a license for a space mining mission.

Mongolia announced plans to double the amount of land available for exploration from about 10 percent of the country's land mass to nearly 21 percent. Mongolia's Parliament approved a resolution to nationalize copper, gold and iron ore assets in the country.

According to Russian miner Polymetal International plc, only 15 percent of the gold produced in Russia comes from deposits that were discovered in the last 20 years. Many of the gold projects brought into development were discovered in Soviet times up to 70 years ago, and only limited exploration has taken place in Russia in recent years. In 2017, however, the China Gold Association signed an agreement to facilitate investment in mineral exploration and extraction in the Magadan region of Russia.

The Saudi Geological Survey began an exploration survey for uranium and thorium resources in the Al Hail Province of Saudi Arabia. The survey is intended to enhance mineral exploration for these resources in support of the country's power generation, seawater desalination and renewable energy resources. ■

For more information

The USGS collects and analyzes data on more than 100 mineral commodities in the United States and worldwide. This article draws from public and private sector sources and the knowledge and expertise of USGS mineral commodity, country, and mineral-resource specialists. More detailed information on the material covered in this article may be obtained from the lead author, David Wilburn, U.S. Geological Survey, National Minerals Information Center, PO Box 25046, MS 750, Denver Federal Center, Denver, CO 80225-0046; phone 303-236-5213; or wilburn@usgs.gov. For additional USGS information on mineral commodities and international mining activities, inquiries may be directed to Steven Fortier, U.S. Geological Survey, National Minerals Information Center, 988 National Center, Reston, VA 20192; phone 703-648-4920 or sfortier@usgs.gov.