

Exploration Review

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This summary of international mineral exploration activities for the year 2016 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 2016 as compiled by the USGS and 3) regional events and legislation that affected exploration

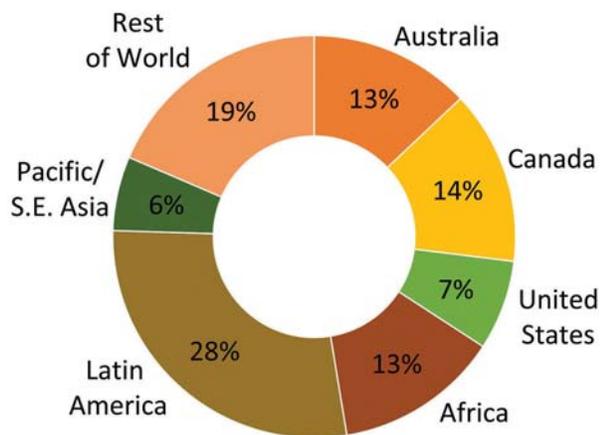
group metals (PGMs) and silver), base metals, (cobalt, copper, lead, molybdenum, nickel, tin and zinc), bulk commodities (bauxite, chromite, iron ore, manganese, phosphate and potash) and other commodities (aluminum, antimony, diamond, graphite, heavy-mineral sands, lithium, niobium, rare-earth elements (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 2016 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was not covered was accounted for by companies that chose not to participate in the SNL survey, private companies that do not publish their budget data and government-funded exploration activities.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 2016 and to report trends in mineral exploration activity for the period 2006 through 2016. These analyses identify where mineral exploration is occurring by commodity and region and the intensity of activity that is taking place in each region for selected mineral commodities and determines those factors that most affect changes in exploration activity.

Certain limitations apply when comparing value 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 exploration budget of \$1 million allocated in 2016 would generally yield less exploration

Figure 1

Planned worldwide exploration budgets for analyzed nonfuel mineral commodities by region for 2016 (1,580 companies' budgets totaling US\$6.89 billion). Source: SNL Metals & Mining, an offering of S&P Global Market Intelligence.

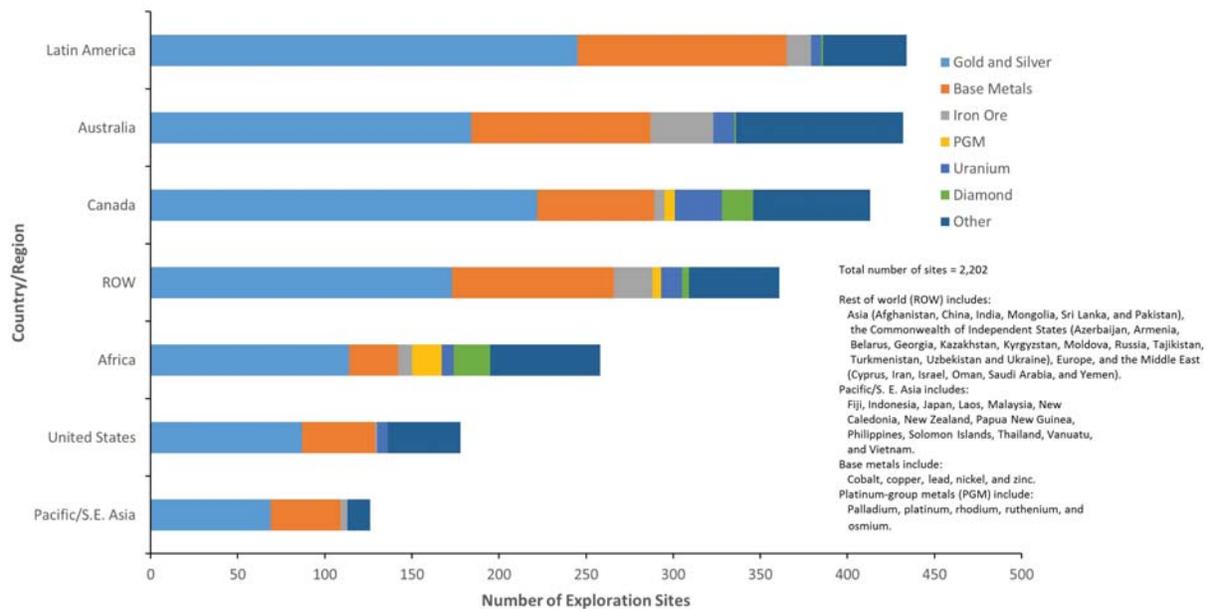


activities including economic, social and political conditions, which were derived from published sources and discussions with USGS and industry specialists. Commodity and regional compilations are presented in this summary. Because multiple sources were used to develop commodity and regional compilations, 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 2016 for 30 nonfuel mineral commodities and metal alloys, based on company surveys. Surveys focused on precious metals (gold, platinum-

Figure 2

Number of active exploration sites by region in 2016. 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.



activity than a corresponding budget in 2006. Fluctuations in currency exchange rates and the value of trading currencies over time can influence the business pattern 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.

2016 global mineral exploration activity and trends from 2006 through 2016

According to SNL, the total estimated worldwide budget allocation for nonferrous mineral exploration decreased by 22 percent in 2016 to about \$6.9 billion (on the basis of data from 1,580 companies, excluding iron ore) from

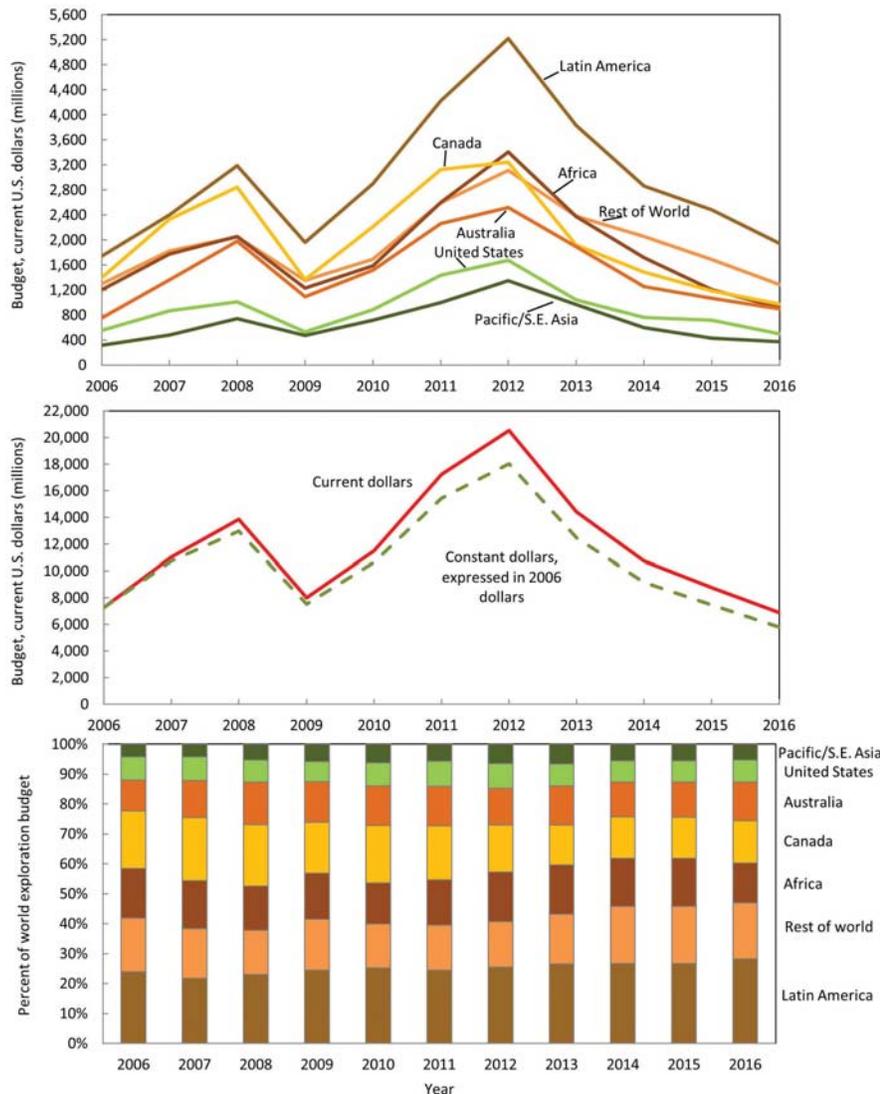
the 2015 budget allocation of about \$8.8 billion (based on 1,798 companies, excluding iron ore). The global budget estimate represents a decade-low level.

Companies continued to reduce spending and streamline project portfolios in an attempt to reassure investors in an uncertain market climate. Lower prices for many mineral commodities experienced during the past several years, increased environmental awareness resulting from a series of mining-related environmental problems, and higher costs for mineral exploration have reduced investor interest and the level of exploration activity. SNL data suggest that 1,178 companies decided to not spend funds on active exploration in 2016, a 9.5 percent increase over the number of companies reporting no exploration budget for 2015.

Figure 1 shows the 2016 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. The 2016 exploration budgets in decreasing order were reported for Latin America, Canada, Africa, Australia, the United States and the Pacific/S.E. Asia region. Exploration taking place in countries included in the “Rest of the World (ROW)” accounted for 19 percent of the global exploration budget.

Figure 3

Trends in reported exploration budgets in selected regions, 2006 through 2016.
Data source: SNL Mining & Metals, an offering of S&P Global Market Intelligence.



The exploration budgets in 2016 in all regions were lower than the corresponding budget in 2015, these year-to-year changes in budgets listed in descending order were: the United States (30 percent), Africa (24 percent), Latin America (22 percent), Canada (18 percent), Australia (16 percent) and Pacific/S.E. Asia (14 percent). The countries comprising the ROW reported a budget decrease of 24 percent. Latin America remained the region with the largest mineral exploration budget, expressed either

in nominal dollars or percent of the global exploration budget.

For 2016, data on 2,202 exploration sites were gathered by USGS specialists from published literature and industry sources. The regional distribution of these exploration targets is represented in Fig. 2 by principal commodity target, based on the number of projects reported for each region. Latin America was the top area in terms of active exploration sites in 2016, followed by Australia, Canada, the ROW, Africa, the United States and the Pacific Region. 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.

Based on mineral exploration drilling data collected by SNL, the number of exploration drill holes completed in 2016 was essentially unchanged from 2015. Drilling in Australia, Canada and the United States together accounted for about 67 percent of the number of holes drilled globally in 2016. 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 2006 through 2016. The top chart of Fig. 3 shows that exploration budgets for 2016 continued to decrease as they have since 2013 in all regions of the world. 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 2006, 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

¹ As defined by SNL, Africa includes countries on the African subcontinent. Latin America includes countries in the Caribbean, Central America, Mexico and South America. The Pacific/S.E. Asia region includes Fiji, Indonesia, Japan, 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.

Table 1

Prices for selected base and precious metals, 2006 through 2016.

Commodity	Average constant price ¹ for specified year, expressed in U.S. currency										
	2006 ²	2007 ²	2008 ²	2009 ²	2010 ²	2011 ²	2012 ²	2013 ²	2014 ²	2015 ³	2016 ³
Copper ⁴	3.15	3.18	3.00	2.19	3.17	3.64	3.19	2.89	2.67	2.11	1.81
Gold ⁵	606	677	823	884	1,120	1,410	1,450	1,200	1,060	959	1,030
Lead ⁶	0.77	1.20	1.13	0.79	0.99	1.09	0.99	0.98	0.90	0.75	0.77
Nickel ⁷	11.0	16.4	9.01	6.03	9.00	9.30	6.90	5.79	6.41	4.43	3.58
Palladium ⁸	323	346	334	241	483	662	563	621	679	573	508
Platinum ⁹	1,140	1,270	1,490	1,100	1,470	1,540	1,350	1,270	1,160	871	816
Silver ¹⁰	11.6	13.0	14.2	13.3	18.4	31.6	27.1	20.3	16.2	13.0	14.1
Uranium oxide ¹¹	47.7	96.1	60.5	42.3	41.8	50.4	42.5	33.1	28.1	30.3	21.7
Zinc ¹²	1.49	1.42	0.80	0.68	0.89	0.89	0.76	0.74	0.82	0.73	0.78
Neodymium oxide ¹³	6.77	12.9	11.6	6.31	19.6	94.9	46.2	27.0	23.9	18.1	14.9

¹ All reported nominal prices converted to constant dollar prices based on the Consumer Price Index for All Urban Consumers using a 2006 base year.

² Price reported in U.S. Geological Survey (USGS), Minerals Yearbook series for the years 2006 through 2014. Price was converted to constant dollar price.

³ Price reported in U.S. Geological Survey, Minerals Commodity Summaries series for the years 2015 and 2016 or updated based on oral and written communications, USGS mineral commodity specialists. Price was converted to constant dollar price.

⁴ U.S. producer cathode (minimum 99.99% pure), reported in dollars per pound. Price was converted to constant dollar price.

⁵ Englehard Corporation industries quotation, reported in dollars per troy ounce. Price was converted to constant dollar price.

⁶ North American producer price, delivered (minimum 99.97% pure), in dollars per pound. In 2015, the North American market price in dollars per pound is reported. Price was converted to constant dollar price.

⁷ London Metal Exchange cash price for primary nickel (minimum 99.80% pure), in dollars per pound. Price was converted to constant dollar price.

⁸ Unfabricated palladium, reported in dollars per troy ounce. Price was converted to constant dollar price.

⁹ Unfabricated platinum, reported in dollars per troy ounce. Price was converted to constant dollar price.

¹⁰ Englehard Corporation industries quotation, reported in dollars per troy ounce. Price was converted to constant dollar price.

¹¹ Nuexco exchange spot price, reported in dollars per pound by the International Monetary Fund. Price was converted to constant dollar price.

¹² London Metal Exchange cash price, reported in dollars per pound. Price was converted to constant dollar price.

that budgeted expenditures in 2016 for sites at late-stage of exploration accounted for about 37 percent of the total global exploration budget, exploration associated with established mine sites accounted for about 35 percent, and early-stage sites accounted for about 28 percent, compared with the 2006 values of 42, 18, and 40 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. Since 2014, however, many junior companies have had difficulty securing sufficient financing to conduct extensive exploration, which often requires more than \$500,000 for an initial drilling program. Consequently, larger companies (major and intermediate companies) contributed a greater share to early-stage exploration, accounting for about 59 percent of the early-stage exploration allocation in 2016. However, junior companies had greater success toward the end of 2016 in raising private capital for their projects.

Many exploration projects are becoming increasingly more costly and difficult to develop. There is a growing trend toward exploring for deeper deposits as shallower reserves are depleted. In South Africa, older, high-cost mines which don't lend themselves to mechanization are being phased out in favor of highly-mechanized mines. In 2015, only

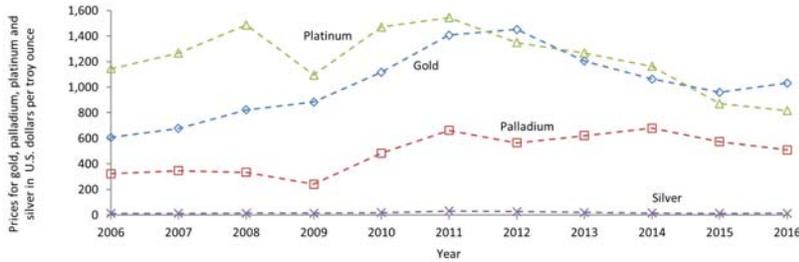
30 percent of the country's PGM production originated from mechanized mines. Increasingly, exploration companies are looking for high-grade deposits in remote areas with limited infrastructure or under covered terrain. Depletion of known shallow deposits has driven exploration companies to look in areas that have traditionally been more cost intensive and technically challenging.

The year 2016 appeared to reflect a turnaround in commodity prices; average 2016 prices for four of the mineral commodities tracked in this analysis increased from average 2015 prices, while average 2016 prices for six other minerals were lower in 2016 than in 2015. It should be noted, however, that peak 2016 prices for all commodities except uranium and neodymium oxide were recorded in the second half of 2016.

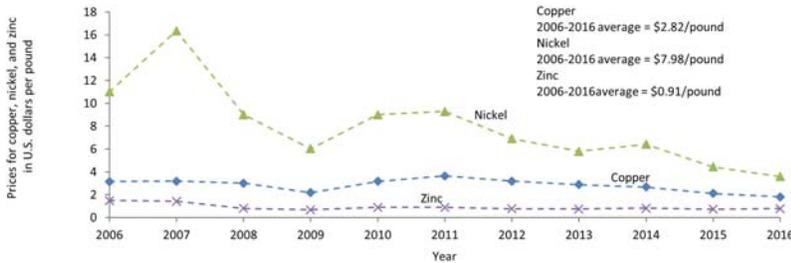
Recent and anticipated mineral commodity prices influence exploration budget development and the amount of activity planned by mineral exploration companies. Table 1 shows the average annual prices in current dollars for selected metals for the years 2006 through 2016. However, because of metal-price 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 2006 constant U.S. dollars for the selected mineral commodities shown in Table 1 for 2006-2016. Using constant dollar values based on the Consumer Price

Figure 4

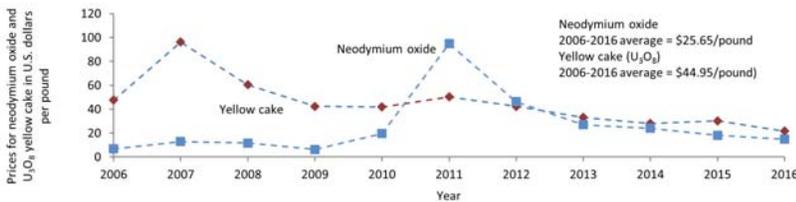
Average constant dollar prices for selected (a) precious metals, (b) base metals, and (c) other selected mineral commodities from 2006 through 2016. Nominal dollar prices from various sources were indexed using the Consumer Price Index with a base year of 2006.



a. Average constant dollar prices for selected precious metals from 2006 through 2016.



b. Average constant dollar prices for selected base metals from 2006 through 2016.



c. Average constant dollar price for other selected mineral commodities from 2006 through 2016.

Index reduces the effects of inflation on prices of mineral commodities being considered over time. When expressed in terms of constant dollars, the average price for eight of the 10 selected commodities was lower in 2016 than the 2006-2016 average price of that commodity, suggesting that overall 2016 metal prices were below the average for the last decade when adjusted for inflation.

The 2016 average constant-dollar price for gold was slightly higher (1.1 percent) than the average 2006-2016 constant-dollar price for gold. Similarly, the average 2016 constant-dollar palladium price was 4.8 percent higher. The 2016 average constant-dollar price for the other commodities shown in Fig. 4 ranged from 14 to 55 percent lower than the average 2006-2016 constant-dollar price for the commodity.

Historical and future trends of metals prices were considered, along with projections of supply and demand that underpin prices, when determining where and what commodity target to spend available capital on exploration and development. Commodity price movements can also alter 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 2016 was 29 percent lower than the peak gold price in 2012. In response to low prices for some commodities, some companies continued to reduce costs by cutting capital expenditures and exploration spending, reducing overhead costs, delaying development, or scaling back mine plans to focus on extracting higher-grade ore, while others were beginning to plan for increased investment in mineral exploration.

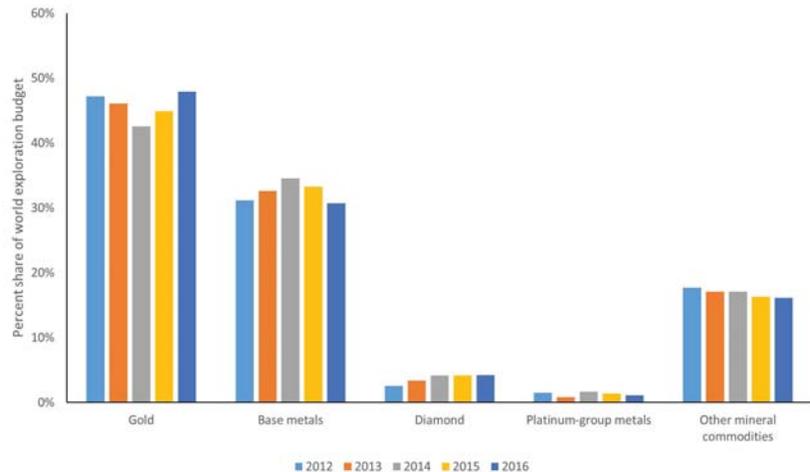
Currency movements were an important consideration for the minerals exploration and mining sector in 2016. The U.S. dollar continued to strengthen against many other major currencies in 2016. A strong U.S. dollar makes U.S. mining-

related exports more expensive for other countries and increases 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 stronger dollar may reduce or partially mitigate costs incurred in local currencies. Lower fuel prices have positively affected the cost of exploration in 2016. Staffing levels also played an important role, as more than half (55 percent) of the employers in the mining industry expected to reduce their workforce in 2016.

Ernst & Young Global Limited estimated the greatest business risks for the mining and minerals exploration industry in 2016-2017, in order of importance, as: the need for cash optimization, the ability to access capital, productivity, the need for transparency,

Figure 5

Worldwide exploration budgets for selected mineral commodity targets, 2012-2016. (Other minerals include iron ore, lithium, molybdenum, niobium, phosphate, potash, rare-earth elements, silver, tantalum, tin and uranium. Expresses as percentage of nominal dollar budget.) Data source: SNL Mining & Metals, and offering of S&P Global Market Intelligence.



preparation for future growth, access to energy, risks associated with joint ventures, cyber security and the need for innovation.

During 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 have declined since 2012; miners have focused on a strategy of retrenchment, project prioritization and divestment of high-cost or non core assets. The decline in exploration financing has affected the junior companies more than larger companies with other sources of revenue. Junior companies, traditionally focused on early-stage exploration, have had to be selective to keep their exploration activities in line with available financing. Major companies have been focusing their exploration efforts near existing mines rather than new territory. They have increasingly relied on the junior companies for initial exploration, and when a promising prospect is identified, they often choose to form a partnership or take an equity stake in the junior to secure rights to the resource. Since 2011, junior companies' share of the global exploration budget has decreased from about 44 percent to about 26 percent in 2016; major companies share has increased from 39 percent in 2011 to almost 53 percent in 2016.

In 2016, some key metal prices began to increase, primarily reflecting stronger Chinese economic activity and demand for selected metals. 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 continue to decline, the average deal size appears to have increased, and the majority of transactions took place within country boundaries owing to the high cost of transporting ores and refined metals. The Pacific/S.E. Asia region continues to dominate merger and acquisition activity for mining projects.

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 2016. SNL data suggest that the share of companies headquartered in these three countries has since declined from about 69 percent in 2007 to less than 52 percent in 2016.

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 2016 budget for these countries in constant-dollars was about half of the combined budget for these countries in 2012. In 2016, resource-endowed countries, such as Iran and Saudi Arabia, were seeking to diversify their economies by expanding their efforts to develop their nonfuel resources. Iran, for example, has received investment from Chinese and Russian companies to explore and develop the country's gold resources.

Competing demand for energy and water have increased risks related to energy and water access. As exploration was taking place in more remote locations, countries such as Australia, Canada, Chile and South Africa were focusing 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 attention to explore the ocean floor for its resource

Table 2

Selected noteworthy exploration sites for 2016.

Location	Type ¹	Site	Commodity	Company	Resource ² notes
Africa					
1 Burkina Faso	F	Banfora	Au	Teranga Gold Corp.	826,000 oz Au (R)
2 Burkina Faso	E	Batie West	Au	Centamin plc.	1.9 Moz Au (D)
3 Burkina Faso	E	Central/So. Houunde	Au	Acacia Mining plc.	2.1 Moz Au (IF)
4 Burkina Faso	P	Karma	Au	Endeavor Mining Corp.	949,000 oz Au (R)
5 Burkina Faso	F	Kiaka	Au	B2Gold Corp.	4.0 Moz Au (D)
6 Burkina Faso	P	Mana	Au	SEMAFO Inc.	2.0 Moz Au (R)
7 Burkina Faso	F	Natougou	Au	SEMAFO Inc.	1.3 Moz Au (R)
8 Congo, Dem. Rep. of	E	Kamoa-Kakula	Cu	Ivanhoe Mines Ltd.	2.8 Mt Cu (R)
9 Cote d'Ivoire	P	Ity	Au	Endeavour Mining Corp.	1.9 Moz Au (R)
10 Cote d'Ivoire	E	Kalamon	Au	Centamin plc.	Data not released.
11 Kenya	E	W. Kenya/Kakamega	Au	Anglogold Ashanti Ltd.	33 kt Cu, 72 kt Zn, 27 koz Au, 1.7 Moz Ag (D)
12 Mali	D	Fekola	Au	B2Gold Corp.	3.7 Moz Au (R)
13 Mali	P	Tabakoto	Au	Endeavour Mining Corp.	725,000 oz Au (R)
14 South Africa	E	Waterberg	Pt, Pd, Au, Rh	Platinum Group Metals Ltd.	7.4 Moz Pt, 15 Moz Pd, 1.8 Moz Au; 281,000 oz Rh (D)
15 Tanzania	P	Bulyanhulu	Au	Acacia Mining plc.	6 Moz Au (R)
Australia					
16 New South Wales	P	Cowal	Au	Evolution Mining Ltd.	2.8 Moz Au (R)
17 Northern Territory	E	Central Tanami	Au	Northern Star Resources Ltd.	1.6 Moz Au (D)
18 South Australia	F	Hillside	Cu, Au	Rex Minerals NL	509,000 t Cu, 432,000 oz Au (R)
19 Victoria	P	Fosterville	Au	Newmarket Gold Inc.	388,000 oz Au (R)
20 Western Australia	E	Blue Spec Shear	Au, Sb	Novo Resources Corp.	124,000 oz Au, 3,400 t Sb (D)
21 Western Australia	P	Carosue Dam	Au	Saracen Mineral Holdings Ltd.	587,000 oz Au (R)
22 Western Australia	E	Coolgardie	Au	Focus Minerals Ltd.	2.5 Moz Au (D)
23 Western Australia	F	Hermes	Au	Northern Star Resources Ltd.	218,000 oz Au (R)
24 Western Australia	P	Jaguar	Zn, Cu, Ag, Au	Independence Group NL	88,000 t Zn, 20,000 t Cu, 4.7 Moz Ag, 27,000 oz Au (R)
25 Western Australia	E	Karlawinda/Bibra	Au	Capricorn Metals Ltd.	914,000 oz Au (IF)
26 Western Australia	P	Long	Ni, Cu	Independence Group NL	14,000 t Ni (R)
27 Western Australia	E	Mt. Holland	Li	Kidman Resources Ltd.	1.1 Mt Li ₂ O (D)
28 Western Australia	D	Mt. Marion	Li, Fe	Mineral Resources Ltd.	390,000 t Li ₂ O, 306,000 t Fe (ID)
29 Western Australia	F	Mt. Morgans	Au	Dacian Gold Ltd.	1.2 Moz Au (R)
30 Western Australia	F	Mulga Rock	Uranium	Vimy Resources Ltd.	14,000 t U ₃ O ₈ (PR)
31 Western Australia	P	Mungari	Au	Evolution Mining Ltd.	665,000 oz Au (R)
32 Western Australia	P	Nullagine	Au	Millennium Minerals Ltd.	184,000 oz Au (R)
33 Western Australia	D	Pilgangoora	Li, Ta	Pilbara Minerals Ltd.	883,000 t Li ₂ O, 9,200 t Ta ₂ O ₅ (R)
34 Western Australia	F	Springfield	Cu, Au	Sandfire Resources Ltd.	97,000 t Cu, 54,000 oz Au (D)
35 Western Australia	P	Thunderbox	Au	Saracen Mineral Holdings Ltd.	864,000 oz Au (R)
36 Western Australia	P	Tropicana	Au	Anglogold Ashanti Ltd.	2.4 Moz Au (R)
37 Western Australia	F	Yamarna belt	Au	Gold Fields Ltd.	3.5 Moz Au (R)
Canada					
38 British Columbia	P	Cariboo/Cow Mtn.	Au	Barkerville Gold Mines Ltd.	2.9 Moz Au (D)
39 British Columbia	E	Island Mountain	Au	Barkerville Gold Mines Ltd.	Data not released.
40 British Columbia	E	Kerr-Sulphurets/ Mitchell	Au, Cu, Ag, Mo	Seabridge Gold Inc.	39 Moz Au, 4.6 Mt Cu, 183 Moz Ag, 94 kt Mo (R)
41 British Columbia	E	Premier	Au, Ag	Ascot Resources Ltd.	2.5 Moz Au, 21 Moz Ag (D)
42 Manitoba	E	Lynn Lake	Au	Alamos Gold Inc.	2.6 Moz Au (D)
43 Nunavut	E	Amaruq	Au	Agnico-Eagle Mines Ltd.	3.7 Moz Au (IF)
44 Northwest Territory	E	Yellowknife City	Au	TerraX Minerals Inc.	Data not released.
45 Ontario	P	Detour Lake	Au	Detour Gold Corp.	16.4 Moz Au (R)
46 Ontario	E	Golden Bear/Garrison	Au	Osisko Mining Inc.	1 Moz Au (D)
47 Ontario	E	Golden Highway	Au	Moneta Porcupine Mines Inc.	1.1 Moz Au (D)
48 Ontario	E	Hasaga	Au	Premier Gold Mines Ltd.	1.1 Moz Au (D)
49 Ontario	P	Island Gold	Au	Richmont Mines Inc.	562,000 oz Au (R)
50 Ontario	P	Macassa/So. Claims	Au	Kirkland Lake Gold Inc.	1.5 Moz Au (R)
51 Ontario	E	Madsen	Au	Pure Gold Mining Inc.	928,000 oz Au (ID)
52 Ontario	P	Red Lake	Au	Goldcorp Inc.	2.1 Moz Au (R)
53 Ontario	E	Whitney	Au	Tahoe Resources Inc.	709,000 oz Au (D)
54 Quebec	F	Bachelor Lake	Au	Metanor Resources Inc.	200,000 oz Au (R)
55 Quebec	P	Canadian Malartic/ Malartic CHL	Au	Agnico Eagle Mines Ltd.	7.7 Moz Au (R)
56 Quebec	E	Clearwater/ Eau Claire	Au, Te	Eastmain Resources Inc.	950,000 oz Au, 40 t Te (D)

Location	Type ¹	Site	Commodity	Company	Resource ² notes
57 Quebec	E	Coulon	Zn, Cu, Ag, Au, Pb	Osisko Gold Royalties Ltd.	133 kt Zn, 47 kt Cu, 4.4 Moz Ag, 30 koz Au, 15 kt Pb
58 Quebec	P	Elenore	Au	Goldcorp Inc.	4.6 Moz Au (R)
59 Quebec	E	Horne 5	Au, Cu, Zn, Ag	Falco Resources Ltd.	4.6 Moz Au, 164 kt Cu, 765 kt Zn, 29 Moz Ag (D)
60 Quebec	E	LaMaque	Au	Integra Gold Corp.	1.1 Moz Au (D)
61 Quebec	E	Windfall Lake	Au	Osisko Mining Inc.	748,000 oz Au (D)
62 Saskatchewan	E	Rook 1/Arrow	Uranium	NexGen Energy Ltd.	81 kt U ₃ O ₈ (D)
63 Saskatchewan	P	Seabee	Au	Silver Standard Resources Inc.	239,000 oz Au (R)
64 Saskatchewan	E	Wheeler River	Uranium	Denison Mines Corp.	32 kt U ₃ O ₈ (D)
65 Yukon Territory	E	Kudz Ze Kayah	Zn, Pb, Cu, Ag, Au	BMC Ltd.	1.2 Mt Zn, 373 kt Pb, 166 kt Cu, 90 Moz Ag, 859 koz Au (D)
Latin America					
66 Argentina	E	Chinchillas	Ag, Zn, Pb	Silver Standard Resources Inc.	100 Moz Ag, 195 kt Zn, 280 kt Pb (D)
67 Argentina	P	San Jose	Ag, Au	Hochschild Mining plc.	29 Moz Ag, 431,000 oz Au (R)
68 Brazil	P	Chapada	Cu, Au	Yamana Gold Inc.	1.4 Mt Cu, 4.1 Moz Au (R)
69 Brazil	E	Coringa	Au	Anfield Gold Corp.	553,000 oz Au (D)
70 Brazil	P	Fazenda Brasileiro	Au	Yamana Gold Inc.	392,000 oz Au (R)
71 Brazil	P	Jacobina	Au	Yamana Gold Inc.	2 Moz Au (R)
72 Brazil	P	Tucano	Au	Beadell Resources Ltd.	345,000 oz Au (R)
73 Brazil	P	Turmalina	Au	Jaguar Mining Inc.	185,000 oz Au (R)
74 Chile	E	Alturas	Au	Barrick Gold Corp.	5.5 Moz Au (IF)
75 Chile	E	El Penon	Au, Ag	Centenera Mining Corp.	1.5 Moz Au, 50 Moz Ag (R)
76 Chile	E	Salares Norte	Au, Ag	Gold Fields Ltd.	977,000 oz Au, 18 Moz Ag (D)
77 Ecuador	E	Cascabel	Au	SolGold plc.	Data not released.
78 Mexico	E	El Barqueno	Au, Ag, Cu	Agnico Eagle Mines Ltd.	607 koz Au, 3.6 Moz Ag, 37 kt Cu (IF)
79 Mexico	P	Guanajuato	Ag, Au	Great Panther Silver Ltd.	3 Moz Ag, 44 koz Au (D)
80 Mexico	P	Multos	Au	Alamos Gold Inc.	1.5 Moz Au (R)
81 Mexico	P	Palmarejo	Ag, Au	Coeur Mining Inc.	45 Moz Ag, 690 koz Au (R)
82 Mexico	P	Platosa	Ag, Pb, Zn	Excellon Resources Inc.	10 Moz Ag, 35 kt Pb, 42 kt Zn (D)
83 Mexico	E	San Sebastian/Terronera	Ag, Au	Endeavor Silver Corp.	22 Moz Ag, 156 koz Au (D)
84 Peru	P	Yauricocha	Ag, Cu, Zn, Pb, Au	Sierra Metals Inc.	7.4 Moz Ag, 32 kt Cu, 111 kt Zn, 44 kt Pb, 76 koz Au (R)
Pacific region					
85 New Zealand	P	Macraes	Au	OceanaGold Corp.	1.2 Moz Au (R)
86 New Zealand	P	Waihi	Ag, Au	OceanaGold Corp.	1.3 Moz Ag, 380 koz Au (R)
United States					
87 Alaska	P	Kensington	Au	Coeur Mining Inc.	560,000 oz Au (R)
88 Alaska	P	Pogo	Au	Sumitomo Metal Mining Co.	5 Moz Au (R)
89 Alaska	E	Tetlin	Au, Ag, Cu	Contango Ore Inc.	664 koz Au, 2.3 Moz Ag, 15 kt Cu (D)
90 Arizona	E	Hermosa/Taylor	Ag, Au, Zn, Pb, Mn, Cu	Arizona Mining Inc.	292 Moz Ag, 363 koz Au, 2.9 Mt Zn, 2.5 Mt Pb, 5.3 Mt Mn, 104 kt Cu (D)
91 California	E	Castle Mountain	Au	Castle Mountain Mining Co. Ltd.	4.1 Moz Au (D)
92 Michigan	P	Eagle	Ni, Cu, Co	Lundin Mining Corp.	95 kt Ni, 82 kt Cu, 3 kt Co (R)
93 Nevada	P	Bald Mountain	Au	Kinross Gold Corp.	1.1 Moz Au (R)
94 Nevada	P	Railroad-Pinion	Au	Gold Standard Ventures Corp.	630,000 oz Au (D)
95 Nevada	P	Rochester	Ag, Au	Coeur Mining Inc.	79 Moz Ag, 477,000 oz Au (R)
96 South Carolina	D	Haile	Au	OceanaGold Corp.	2 Moz Au (R)
Rest of the World					
97 Bulgaria	P	Chelopech	Au, Cu, Ag	Dundee Precious Metals Inc.	2.2 Moz Au, 202 kt Cu, 4.9 Moz Ag (R)
98 Serbia	E	Timok	Cu, Au	Nevsun Resources Ltd.	229 kt Cu, 568 koz Au (D)
99 Sweden	E	Barsele	Au, Cu, Zn, Ag	Agnico Eagle Mines Ltd.	558 koz Au, 583 t Cu, 792 t Zn, 107 koz Ag (D)
100 Turkey	P	Copler/Cakmaktepe	Au, Ag, Cu	Alacer Gold Corp.	4.3 Moz Au, 10 Moz Ag, 23 kt Cu (R)

Moz—million troy ounces; Mt—million metric tons; t—metric tons; oz—troy ounces; Ag—silver; Au—gold; Co—cobalt; Cu—copper; Li—lithium; Mo—molybdenum; Nb—niobium; Ni—nickel; Pb—lead; Pd—palladium; PGM—platinum-group metals; Pt—platinum; REE—rare-earth elements; Rh—rhodium; REO—rare-earth oxide; Sc—scandium; Ta—tantalum; U₃O₈—uranium oxide; Y—yttrium; Zn—zinc.

¹ D—Approved for development; E—Active exploration; F—Feasibility work ongoing/completed; LP—Limited production; P—Exploration at producing site. ² Resource estimate as of end of 2016 derived from various 2016 sources: D—measured + indicated; ID—indicated; IF—inferred; PR—probable; R—proven + probable.

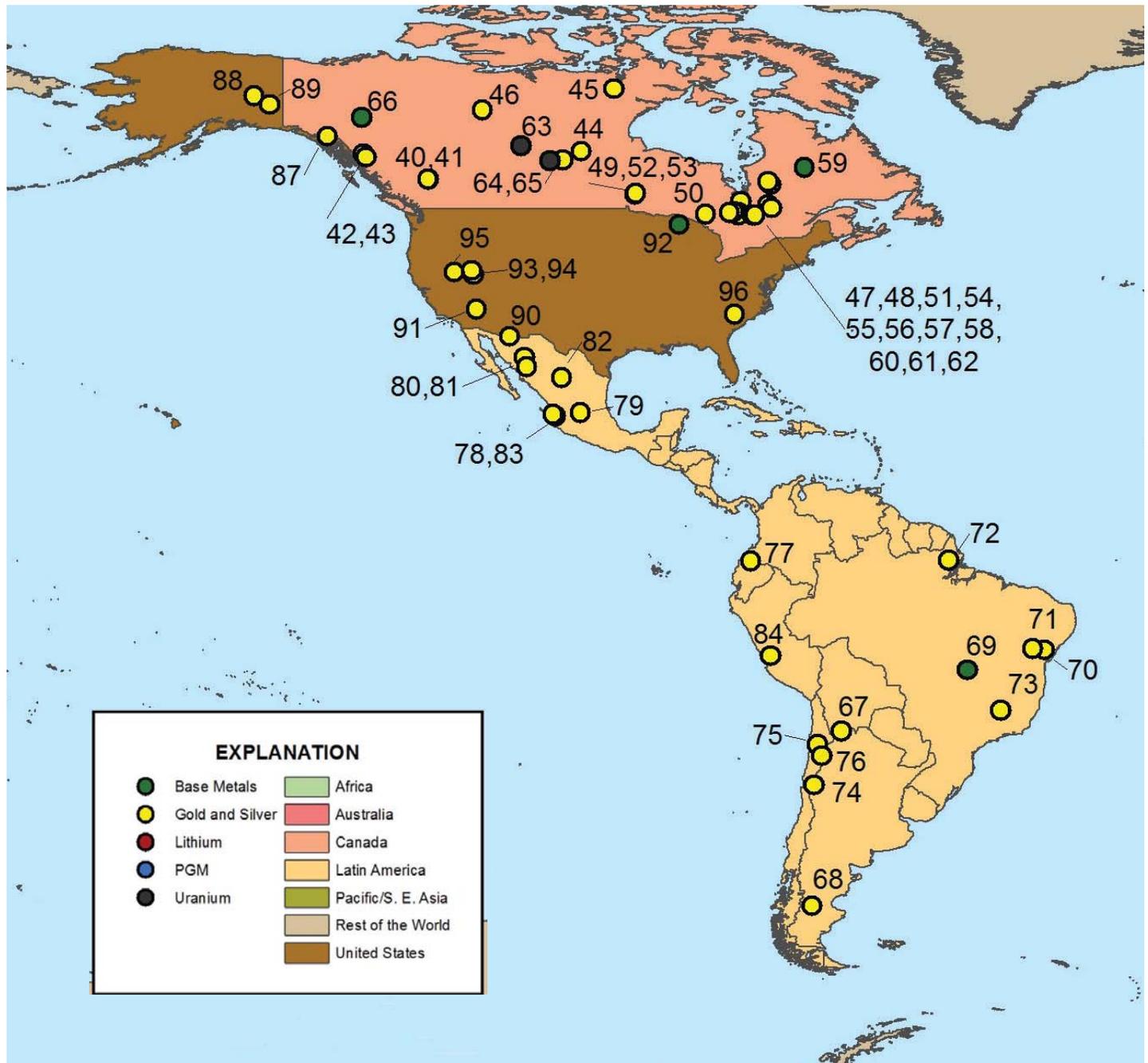
Data were not verified by the U.S. Geological Survey. Where resource data were not released, the site was considered noteworthy by the authors based on the level of exploration activity or regional significance.

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 International Seabed Authority (ISBA), an autonomous international organization established under 1994 provisions of the United Nations Convention on the Law of the Sea, was drafting regulations in 2016

governing exploration and exploitation of undersea mineral resources. In 2016, the ISBA signed an exploration contract for exploration in the Clarion-Clipperton zone in the Pacific Ocean with the Cook Islands Investment Corp. and one with the Government of India for exploration in the Indian Ocean.

Figure 6

Regional exploration map showing the selected noteworthy sites for mineral exploration in 2016 by commodity.

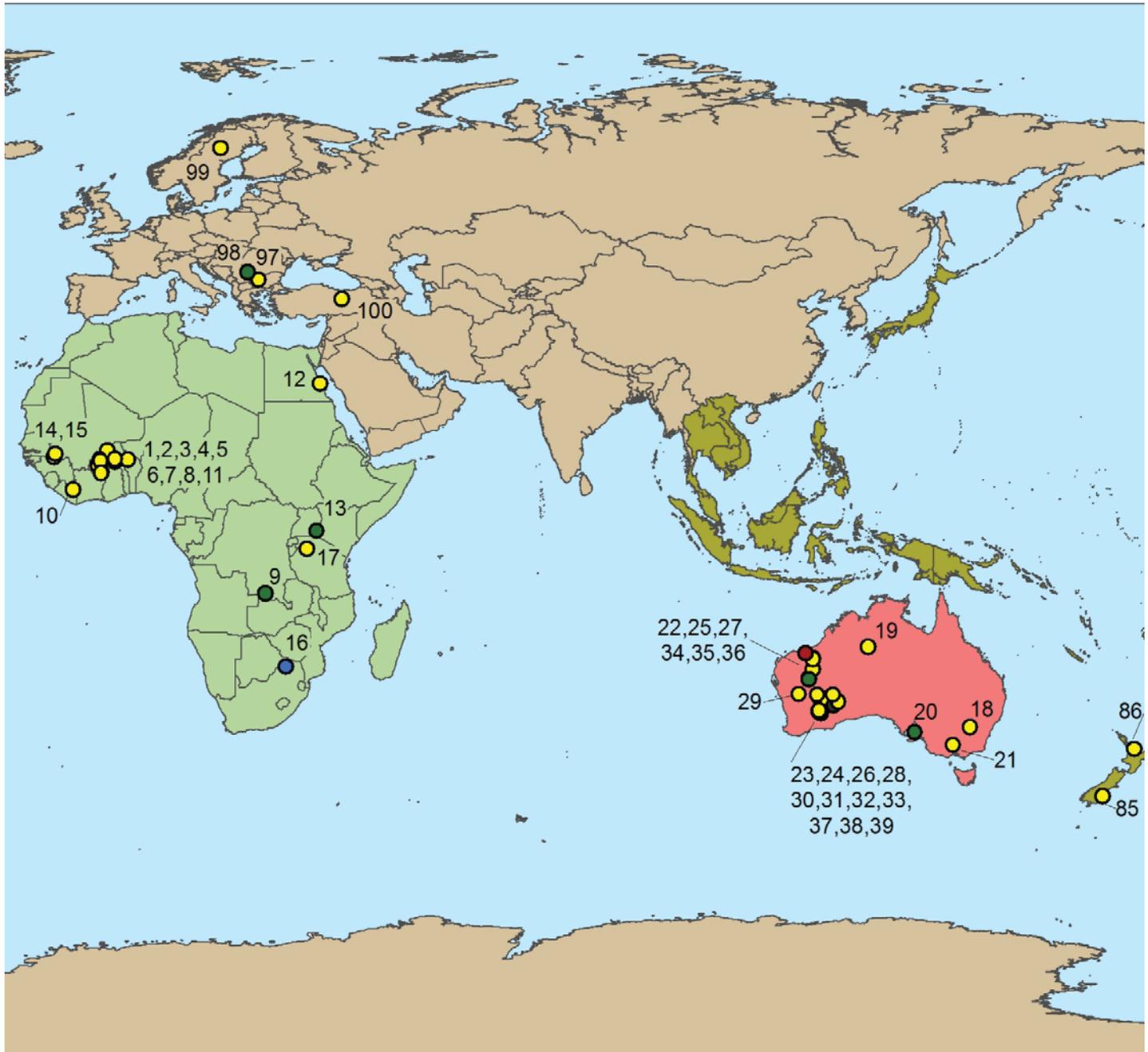


Exploration activity by mineral commodity

The amount budgeted for gold exploration in 2016 (\$3.3 billion) based on SNL data was 16 percent lower than that budgeted for gold in 2015. Figure 5 illustrates the 2012 through 2016 global percent share distribution of reported mineral exploration budget estimates by mineral commodity grouping (excluding

iron ore and uranium). The percent share attributed to global gold exploration relative to exploration for all nonfuel minerals decreased for the years 2012 through 2014 then increased from 2014 to 2016. In terms of percentage of worldwide nonfuel exploration budget, exploration for gold accounted for 48 percent in 2016, compared to 45 percent in 2015 and 43

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



percent in 2014. The apparent increase from 2015 to 2016 reflects a greater decrease in exploration budget for other commodities than the decrease in budget for gold, so on a relative scale, the percent allocated to gold increased.

Latin America remains the leading region for gold exploration based on SNL data, accounting for about 26 percent of gold budget allocations. The traditional leading countries, Australia, Canada and the United States, accounted for 39 percent of global exploration budget for gold. Australia overtook Canada as the leading gold exploration country in 2016 for the first time since 2003. Although the gold budget for major companies declined by 7 percent in 2016 from 2015, the percentage share of the major company budgets for gold increased to 55 percent, while the budget for junior companies as a whole decreased by 28 percent and now only has a 25 percent share.

Exploration budgets for base-metal projects decreased 28 percent from \$2.9 billion in 2015 to \$2.1 billion in 2016. In terms of percentage of total worldwide nonfuel exploration budget, the estimated base-metal exploration budget decreased to 31 percent in 2016 from 33 percent in 2015. The percent allocation for base-metal exploration increased from 2012 through 2014, then it decreased from 2014 through 2016, mainly because of copper. Exploration for copper accounted for about 71 percent of the base-metal budget for 2016, zinc exploration accounted for about 18 percent and nickel exploration accounted for 11 percent. Latin America retained the greatest percent share (36 percent). The leading three countries for copper exploration in 2016 based on SNL budgets in descending order were Chile, Peru and Australia, together accounting for about 39 percent of the global copper exploration budget. The leading three countries for lead/zinc exploration in 2016 in descending order were Peru, China and Australia, together accounting for about 39 percent of the global lead/zinc exploration budget. The leading three countries for nickel exploration in 2016 in descending order were Australia, Indonesia and Canada, together accounting for about 40 percent of the global nickel exploration budget.

The budget for diamond exploration decreased 21 percent in 2016 from 2015. The diamond exploration budget of about \$290 million in 2016 represented about 4 percent of the global exploration budget, about the same as its share in 2015. The three leading locations for diamond exploration, in descending order by 2016 budget, were Canada, Russia and Botswana, together accounting for about 74

percent of the global exploration budget for diamond.

The exploration budget estimate in 2016 for PGM of \$74 million represented a 15-year low. The SNL budget estimate was 38 percent lower than its 2015 budget estimate of \$120 million and represented about 1 percent of the global exploration budget for 2016. The three leading locations for PGM exploration in descending order were South Africa, Canada and Russia, together accounting for about 88 percent of the global exploration budget for PGMs. The decline in PGM exploration reflects decreased demand from China, primarily for platinum jewelry.

The estimated 2016 global budget for other mineral commodity targets was 24 percent lower in 2016 than the budget reported for 2015. Mineral commodities considered in this category include but are not limited to graphite, heavy-mineral sands, lithium, manganese, molybdenum, niobium, phosphate, potash, REE, silver, tantalum, tin and tungsten. The exploration budget for lithium increased 88 percent in 2016, as the search for deposits suitable for supplying the lithium-ion battery sector expanded. Concern about China being the predominant source of supply and its policies related to export quotas for REE has led to increased exploration for REE at projects in the United States, Canada, Australia, Latin America and Europe, based on the number of active exploration sites.

The budget estimate for uranium exploration decreased about 15 percent to \$284 million in 2016 from about \$334 million in 2015. 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 2016 were Canada, Australia and Kazakhstan, together accounting for about 70 percent of the global exploration budget for uranium.

Based on global exploration site data compiled by the USGS, gold was the principal target at 45 percent of the sites explored in 2016; copper was the target at 15 percent of the sites; lithium was the target at 6 percent of the sites; silver was the target at 5 percent of the sites; iron ore and lead/zinc each represented about 4 percent of the sites; graphite, nickel and uranium each represented about 3 percent of the sites and diamond and potash each represented about 2 percent of the sites. Approximately 8 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, REE and tungsten, but, with the exception of lithium, the number of companies exploring for these commodities has declined from the 2012 peak.

2016 exploration highlights

Table 2 presents selected noteworthy exploration sites based on the amount of exploration activity conducted in 2016. The USGS does not assume responsibility for errors or omissions. A combined total of about 4.6 million meters of drilling took place in 2016 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 either by intensity of drilling activity or level of planned and executed exploration budget. When drilling was used as the principal indicator, a site qualified if a minimum of 20,000 meters of drilling (usually a combination of diamond or reverse-circulation drilling) took place during 2016 along with ancillary exploration activities. Where budget was used as the principal indicator, a site qualified if a 2016 budget of at least \$4 million was planned and executed for exploration and drilling activities. These criteria may eliminate early-stage projects (where the level of drilling was below cutoff) or development projects (where planned expenditures include costs for development or infrastructure). The magnitude of resource delineated when compared to prior resource estimates.
- 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 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 2016 were not included in Table 2 if the reported level of 2016 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 in *Mining Engineering*.

For 2016, gold continued to be the commodity generating the greatest exploration intensity by number of projects based on the list of noteworthy exploration sites as reported in Table 2. Of the sites selected for Table 2, the primary targets were: (1) gold or silver at 83 percent of the sites; (2) base metals at 11 percent of the sites; (3) uranium at 3 percent of the sites; (4) lithium at 2 percent of the sites (5) and PGMs 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 11 million tonnes (Mt) of copper; about 10 Mt of lead and zinc; about 5 Mt of manganese; about 2.4 Mt of lithium; 300,000 (kt) of iron ore; 127 kt of U_3O_8 ; 109 kt of nickel; 94 kt of molybdenum; 31 kt (1 billion troy ounces) of silver; 9.2 kt of tantalum; 5.8 kt (190 million troy ounces (Moz)) of gold; 3.4 kt of antimony; 3 kt of cobalt; 700 t (23 Moz) of PGM and 40 t of tellurium 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 2016 survey (published March 1, 2017) includes data from 350 respondent companies with an aggregated exploration budget of \$2.7 billion in 2016, down from \$3.2 billion in 2015.

According to the Fraser Institute survey, the top 10 destinations for mineral exploration based on overall investment attractiveness

in 2016, listed in descending order, were Saskatchewan (Canada), Manitoba (Canada), Western Australia (Australia), Nevada (United States), Finland, Quebec (Canada), Arizona (United States), Sweden, Ireland and Queensland (Australia). The top 10 destinations for mineral exploration based on their mineral potential independent of policy restrictions, listed in descending order, were Western Australia (Australia), Manitoba (Canada), Saskatchewan (Canada), Queensland (Australia), Quebec (Canada), Arizona (United States), the Democratic Republic of Congo, Nevada (United States), Cote d'Ivoire and the Philippines. The top 10 destinations for mineral exploration based solely on policy attractiveness, listed in descending order, were Ireland, Saskatchewan (Canada), Sweden, Finland, Nevada (United States), Manitoba (Canada), Wyoming (United States), New Brunswick (Canada), Western Australia (Australia) and Northern Ireland.

Exploration activity and related legislation by region

Exploration-related activities and events within each region are summarized in the following section. The order of regional and country discussions is based on the amount budgeted for exploration in 2016 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, and was the leading region for exploration based on USGS data for all active sites. Based on SNL data, the Latin America mineral exploration budget decreased by about 24 percent to about \$1.9 billion in 2016 from \$2.5 billion in 2015, representing about 28 percent of the estimated overall worldwide exploration budget for 2016. 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 (118), Brazil (83), Chile (72), Peru (61), Argentina (35), Colombia (14), Nicaragua (10), Dominican Republic (7), Ecuador (6) and Guyana (6).

Approximately 56 percent of the deposits actively explored in 2016 in Latin America contained gold or silver, and 28 percent contained base metals, or some combination of precious and base metals, based on the

sites considered in the USGS compilation. Activity in 2016 was used to further define early-stage discoveries (45 percent), conduct exploration at a producing site (37 percent), conduct prefeasibility and feasibility studies of economically promising prospects (9 percent) and further explore for resources of deposits under development (6 percent) and projects placed on care and maintenance (3 percent).

Based on SNL data, major companies accounted for the majority (69 percent) of the Latin American exploration budget, followed by junior companies (19 percent), intermediate companies (10 percent), and governments and other types of companies (2 percent). All company types decreased in budget share from 2015 to 2016, with junior companies having the largest decrease of more than 30 percent.

Latin America continues to be one of the leading regions for mineral exploration by many companies as has been shown in past decade 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. Although the overall trends of budget expenditures have declined for all regions since 2012, Latin America remained the leading region for exploration. Exploration budgets in Latin America have declined 63 percent from 2012 to 2016. In 2012, Latin America reported exploration budgets of more than \$5.2 billion in 2013 this dropped to \$3.8 billion and on down to \$1.9 billion for 2016. With the sliding trend in exploration budgets, Argentina, Bolivia, Brazil, Colombia, Ecuador, Mexico Peru and Venezuela were attempting to make local investment environments more attractive through changes in legislation and tax incentives for mining investors.

According to the 2016 Fraser Institute survey, Peru was the most attractive Latin American country for mining investment, overtaking Chile from the top ranking in 2015. Venezuela was listed last among Latin American countries. The data produced by the Fraser Institute correlate with the attractive investment climate rankings *Business News Americas* (BN Americas) reports in its "Mining Survey 2017", in which Peru and Chile were the top two countries in Latin America ranked on business investment.

Of the Latin American countries, the lithium industry is most mature in Chile, where infrastructure is more in place compared to the surrounding countries. Lithium demand is on the rise worldwide for production of 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 70 percent of the world’s known lithium deposits located on the salt flats covering portions of all three countries. 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, extensive state control and high taxes that are hindering investment.

Since coming into office in January 2016, Argentina’s president, Mauricio Macri, has instituted changes in the mining industry, such as eliminating export taxes on precious and base metals. He also created the Ministry of Energy and Mines in an effort to make Argentina more attractive for mining investment. In 2016, Argentina had a 13 percent increase in exploration budgets from 2015 and was one of the few Latin American countries that exhibited a positive change from 2015 to 2016. Of the total exploration sites recorded by the USGS, gold and silver (46 percent) was the most explored for commodity, followed by lithium (31 percent) and copper (14 percent). In Latin America, Argentina ranked as the number one lithium exploration destination in 2016, accounting for 50 percent of total regional exploration of this commodity. Greenfield stage projects were the highest (57 percent) in Argentina of all countries considered in the Latin America region.

Protests have been brought on by the National Federation of Mining Cooperatives of Bolivia in which demands for more mining concessions and relaxed environmental regulations have escalated to the point in which the Deputy Interior Minister was kidnapped and killed by striking miners. Infrastructure development of the Central Bi-Oceanic Railway is moving forward with investment from China as a means to connect projects that extend through Bolivia, Ecuador, Peru and Venezuela.

In Brazil, iron ore continues to be the primary commodity of the mineral industry, though gold is the commodity of highest exploration interest. Gold (43 percent) was the most explored for commodity followed by iron ore (14 percent) based on USGS site data. BN Americas reported that the current regulatory system, including mining code reform, is hindering investment and exploration in Brazil.

According to USGS data, exploration in Chile accounted for about 17 percent of all exploration in Latin America. Copper

represented 65 percent of all metal commodities explored for followed by gold at 22 percent, and a mixture of other commodities represented the remaining 13 percent. There has been a decline in new project development owing to economic conditions based on low commodity prices and reduction of exploration budgets. There has been an increase in mergers and acquisitions of established projects.

Chile’s copper mining industry uses a large amount of desalinated sea water, accounting for more than 70 percent of consumed water in mining operations in Chile. In 2015, the reliance of this water grew by more than 30 percent from 2014. The Escondida Water Supply project is due to come online in 2017, followed by other water supply projects in the coming years.

High electricity costs, low copper prices, and falling grades are contributors to Chile’s operating costs remaining as one of the highest in the world. Although Chile is the world’s number one producer of copper, data provided from the Mining Council states operational costs were more than five percent higher than the global average. Investment continues to regress as copper prices, power issues, permitting delays and socio-environmental issues continued to detract investors from Chile.

A law that previously gave the Colombian national government exclusive rights for issuing mining permits was struck down in the Constitutional Court, which now gives local government abilities to regulate its mining industry. The Constitutional Court banned all mining activity in the moorlands, which will affect over 300 mining concessions. This is a subalpine area in the Andes Mountains that had previously banned mining prior to 2011 which supplies water for about 70 percent of Colombia’s population.

The Dominican Republic Energy and Mines Ministry (MEM) approved 21 new exploration concessions between May 2015 and June 2016.

Ecuador’s mining minister states that Ecuador wants to increase its share of Latin American exploration mining investment up to roughly 10 percent over the next five years. Plans to start awarding exploration concessions recommenced in 2016, where gold and copper were the most sought after concessions.

Budget data suggests that metals exploration in Mexico continued on a downward trend, as it has since 2012, although USGS site data retained Mexico at the top of all Latin American countries for exploration. Gold and silver (81 percent) were the most explored for commodities followed by base metals (14 percent). Mexico is attractive to investors due

to low production costs, and exploration for gold, silver and zinc are expected to expand past 2020.

Peru's newly elected president, Ollanta Humala, is taking a diplomatic approach to the fight against illegal mining and the revitalization of previously stalled projects. The administration sees an advantage that Peru has over neighboring countries, as the costs of development and operation are much lower. The new administration is also working to attract increased foreign investment from China in order to advance state-owned projects. The president has pledged to seek elimination of all bureaucratic obstacles that are delaying infrastructure development related to energy and mining projects.

The Venezuelan president, Nicolas Maduro, signed over \$5.5 billion in mining deals in an attempt to reverse the current economic decline. Maduro said that more than \$20 billion in mining investment contracts are expected to be signed in the near term. Although the president is pushing mining investment into the country to stimulate the economy, there are many groups that oppose this because the regions that are to be explored contain minerals on ancestral lands in the Bolivar, Amazonas and Delta Amacuro states.

Canada. Statistics as of September 2016 released by Natural Resource Canada (NRC) show 2016 revised spending intentions at C\$1.5 billion (US\$1.1 billion), down about 20 percent from an actual expenditure of C\$1.8 billion (US\$1.4 billion) for 2015. Based on SNL data, Canadian mineral exploration decreased by about 19 percent to about US\$971 million in 2016 from US\$1.2 billion in 2015, representing about 14 percent of the estimated overall worldwide exploration budget for 2016. NRC statistics include planned exploration expenditures for a wider variety of minerals than were included in the SNL estimates.

As of September 2016, the revised exploration and deposit appraisal budget for precious metals (gold and silver) was C\$767 million (US\$585 million); base metals, C\$217 million (US\$166 million); uranium, C\$178 million (US\$136 million); diamond, C\$68 million (US\$52 million); and iron ore, C\$22 million (US\$16 million) of the C\$1.5 billion (US\$1.1 billion) exploration total. When the NRC exploration statistics were reconfigured to make them comparable with SNL statistics, the reported exploration expenditure by NRC was C\$1.23 billion (US\$940 million), very close to the budget estimate reported by SNL.

Company exploration spending for 2016 as reported by NRC as of September 2016 was greatest in Ontario (26.9 percent of the total exploration and deposit appraisal spending intentions for Canada), Saskatchewan (17.5 percent), Quebec (16.5 percent), British Columbia (14 percent), Nunavut (8.3 percent), Yukon Territory (5.6 percent), Manitoba (3.8 percent), Northwest Territories (3.6 percent), Newfoundland and Labrador (1.4 percent), Alberta (1.3 percent), New Brunswick (0.6 percent) and Nova Scotia (0.5 percent).

Canadian provinces with an increase in exploration activity in 2016 from 2015, based on reported budget allocations from NRC, were Manitoba, with an 18 percent increase, primarily attributed to precious metals exploration and Alberta, with a 4 percent increase, primarily attributed to iron and uranium exploration. Canadian provinces with a decrease in exploration activity in 2016 from 2015 based on reported budget allocations were Newfoundland and Labrador, with a 57 percent decrease, primarily a result of decreased exploration for base metals and iron ore; Northwest Territories, with a 48 percent decrease, primarily a result of decreased exploration for diamond and base metals; Nunavut, with a 43 percent decrease, primarily a result of decreased exploration for precious metals and diamond; British Columbia, with a 41 percent decrease, primarily the result of decreased exploration for base metals, precious metals and other metals; Nova Scotia, with a 33 percent decrease, primarily a result of decreased exploration for precious metals and other metals, coal and nonmetals; New Brunswick, with a 10.5 percent decrease, primarily a result of a decrease in exploration for base metals and other metals, coal and nonmetals; Yukon Territory, with a 10.4 percent decrease, primarily a result of decreased exploration for base and precious metals; Ontario, with a 10.3 percent decrease, primarily a result of decreased exploration for base metals and Quebec, with a 7 percent decrease, primarily a result of decreased exploration for base metals. Exploration in Saskatchewan remained at the 2015 level.

According to NRC, major exploration companies accounted for about 62 percent of Canadian exploration spending intentions in 2016, slightly higher than in 2015. In terms of mineral commodities sought country-wide in 2015, precious metals received the largest exploration spending intention (52 percent), followed by base metals (15 percent), uranium (12 percent), diamond (5 percent), iron ore (2

percent), and other mineral commodities (14 percent).

On the basis of data compiled for this review by the USGS, Canada's provinces or territories with the greatest exploration activity were Quebec (105), Ontario (80), British Columbia (73), Saskatchewan (35), Yukon Territory (31), Newfoundland and Labrador (21), Northwest Territories (18), Nunavut (14), Manitoba (12), New Brunswick (12), Nova Scotia (9) and Alberta (3).

Approximately 54 percent of the deposits actively explored in 2016 in Canada contained gold or silver, 16 percent base metals, 7 percent uranium, 4 percent diamond, 3 percent iron ore and PGMs, and 16 percent other mineral commodities, based on the sites considered in the USGS compilation. Activity in 2016 was used to further define early-stage discoveries (78 percent), conduct exploration at a producing site (12 percent), conduct prefeasibility and feasibility studies of economically promising prospects (7 percent), further explore for resources of deposits under development (1 percent) and projects placed on care and maintenance (2 percent).

The level of nonfuel mineral exploration expenditure in Canada in 2016 declined to a level of about 30 percent of its peak in 2012 and was about 18 percent less in 2016 than in 2015. More than 10 percent of Canadian mining and exploration companies formerly on the Toronto Stock Exchange (321 companies) delisted in 2014 and 2015. Much of the decline in mineral exploration took place in the northern provinces of Canada, areas with limited infrastructure often inhabited by indigenous tribes. In 2016, the government took steps to address these issues, including budgeting C\$120 billion (US\$92 billion) for new and existing infrastructure projects over the next decade, and processes were implemented to provide greater clarity related to the environmental assessment process and indigenous peoples.

As part of its 2016 budget, the Canadian government extended its 15 percent Mineral Exploration Tax Credit through March 31, 2017. The tax credit has been in effect since 2000. The government also announced plans to establish a Canadian Infrastructure Bank and provide C\$5.5 million (US\$ 4.2 million) in research to minimize mining's environmental impact.

The British Columbia provincial government extended its Mining Exploration Tax Credit to Jan. 1, 2020 and renewed the provincial Mining Flow-Through Share tax credit, which expired on Dec. 31, 2015. The Ontario Ministry of Northern Development and

Mines announced a C\$5 million (US\$4 million) investment to support a second round in the Junior Exploration Assistance Program; the first round provided support for 32 exploration projects across northern Ontario in 2015-2016. The Ontario provincial government provided C\$2.5 million (US\$1.9 million) to the Centre for Excellence in Mining Innovation to support research to develop technologies to enhance the efficiency, safety and sustainability of mining operations.

The Fraser Institute report for 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 survey, 73 percent of survey respondents said that permit times had stayed the same in Saskatchewan while respondents from all other provinces/territories report lengthened permit times with Yukon being the extreme of 70 percent.

Africa. Based on SNL data, the Africa mineral exploration budget decreased by about 25 percent to about \$0.9 billion in 2016 from \$1.2 billion in 2015, representing about 13 percent of the estimated overall worldwide exploration budget for 2016. On the basis of data compiled for this review by the USGS, the top 10 African countries with the greatest exploration site activity were South Africa (52), Tanzania (25), Burkina Faso (22), the Democratic Republic of the Congo (DRC) (19), Ghana (16), Botswana (14), Namibia (11), Mali (10), Mozambique (10) and Cote d'Ivoire (9).

Approximately 44 percent of the deposits actively explored in 2016 in Africa contained gold, 11 percent contained base metals, 8 percent contained diamond, 7 percent contained PGMs, and 24 percent of the exploration sites contained other minerals, primarily graphite, heavy minerals, iron ore, lithium, phosphate, potash, and REE, based on the sites considered in the USGS compilation. Activity in 2016 was used to further define early-stage discoveries (47 percent), conduct exploration at a producing site (34 percent), conduct prefeasibility and feasibility studies of economically promising prospects (10 percent), further explore for resources of deposits under development (5 percent) and projects placed on care and maintenance (4 percent).

Based on SNL data, major companies accounted for the major share (45 percent) of the Africa exploration budget, followed by junior companies (27 percent), intermediate companies (20 percent), and governments and other entities (8 percent). All company types

decreased in budget share from 2015 to 2016 with junior companies showing the largest decline, decreasing more than 40 percent.

Since 2012, mineral exploration in Africa has declined in terms of exploration budget and number of active sites. According to SNL, the Africa mineral exploration budget has decreased 73 percent from the most recent peak in 2012. Similarly, the number of active exploration sites in Africa monitored by the USGS decreased about 46 percent from 2012. Principal reasons for the decrease in African mineral exploration include a lack of infrastructure, accessibility to African geodata, and the perception of political risk in some areas of Africa. 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. In order to improve the quantity and accessibility of minerals data, the World Bank has sponsored a geomapping program in Malawi that will eventually encompass much of the African continent and be made available publicly in Africa. The PanAfGeo initiative, a collaboration between the Organization of African Geological Surveys (OAGS) and EuroGeoSurveys (EGS), was initiated in 2016 to increase geoscientific skills in Africa.

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. The number of Chinese-based mining and mineral processing assets in Africa, excluding numerous exploration projects, has increased from a handful in 2006 to more than 120 in 2015. In 2016, Chinese entities announced plans to invest in the DRC, Nigeria and Zambia.

Several countries have announced plans to take back unused exploration and mining permits and re-issue them at auction. Burkina Faso’s Ministry of Mines has published a list of 356 gold permits that have become available for lease. In Guinea, 142 permits covering bauxite, diamond, gold and uranium prospects were taken back.

Despite the DRC’s regulatory uncertainty related to upcoming elections, the DRC continues to be Africa’s leading mineral investment destination, primarily because of its untapped copper and gold resources and lower production costs. The Congolese government awarded a \$660 million contract to a consortium of Chinese investors to build a hydroelectric project in a copper-rich area of the country. Inadequate power supply has required copper

miners to import electricity from neighboring Zambia or invest in expensive diesel-powered generators.

Illegal mining has been a problem in the DRC, Nigeria, South Africa and Ghana, where illegal miners took over AngloGold Ashanti’s Obuasi gold mine. The Ghana Chamber of Mines called for increased enforcement of the 2015 Minerals and Mining Amendment Act, which prohibits illegal mining without a license.

In Kenya, the Mining Act 2016 was signed into law which sets out land policy principles and streamlines the mining sector. This includes establishing a Mineral Rights Board with power to issue or cancel exploration or mining licenses; the creation of the National Mining Corporation, intended to carry out mineral prospecting and mining on behalf of the government, and institute provisions for the oversight of artisanal mining activities. The Senate passed a mining bill that would establish royalty rates ranging from 1-12 percent of the gross sales value of minerals and give the government a 10 percent stake in new mining projects. The government conducted a \$30 million airborne mapping survey across the country.

The Namibian Ministry of Environment and Tourism approved the marine phosphate mining application of the Namibian Marine Phosphate Company based in Oman. The project would be the world’s first sea-bed mining project off the coast of Africa.

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 Parliament passed the Mineral and Petroleum Resources Development Amendment bill in November 2016. The legislation allows the mines minister to place certain minerals in a value-added category, requiring a portion of the extracted resources to be processed domestically and not be exported in raw form.

Sudan and Saudi Arabia have approved a joint-cooperation agreement to explore for mineral resources in the Red Sea off the coast of Sudan by 2020.

The Government of Uganda announced plans to set up a mineral exploration department in the Directorate of Geological Survey and Mines in order to expedite mineral exploration in the country.

The Finance Act of 2016, as proposed by the Tanzanian Government, would require mining firms to list on the Dar es Salaam Stock Exchange no later than two years after approval

of the new regulations and require mining license holders to have a minimum of 30 percent local ownership.

The Zambian Parliament approved a new copper royalty tax. The variable tax will range from 3 to 9 percent for openpit and underground mines and be calculated using the global price of the metal. Zambia continues to suffer from electrical power shortages. Electricity charges were increased in 2016; the mining sector utilizes more than half of the nation's power.

Australia. Based on SNL data, the Australia mineral exploration budget decreased by about 18 percent to about \$0.9 billion in 2016 from \$1.1 billion in 2015, representing about 13 percent of the estimated overall worldwide exploration budget for 2016. The Australian Bureau of Statistics (ABS) reports expected mineral exploration expenditures (including coal and excluding petroleum) for their fiscal year from July 2015 through June 2016 of about A\$1.4 billion (US\$1.0 billion), about a 10 percent decrease from the actual Australian expenditure for fiscal year 2014-2015 of A\$1.6 billion (US\$1.2 billion). According to ABS, Western Australia accounted for 67 percent of the Australian mineral exploration expenditure in 2015-2016; Queensland and New South Wales both accounted for about 9 percent; Northern Territory, about 8 percent; South Australia, about 4 percent; Victoria, about 2 percent and Tasmania, about 1 percent. ABS reported that exploration expenditures increased in Victoria by 27 percent from 2014-2015 to 2015-2016, primarily because of an increase in gold exploration. Exploration expenditures decreased by 42 percent in South Australia, primarily owing to a decrease in exploration for base metals. Exploration expenditures decreased about 33 percent in Tasmania, primarily due to a decrease in iron ore exploration. Exploration in Queensland decreased by about 26 percent.

ABS reports total nonfuel Australian expenditure for metals and minerals for fiscal year 2015-2016 (excluding coal and petroleum). Approximately 23 percent of the 2015-2016 expenditure was for iron ore, a decrease of 32 percent from 2014-2015. Gold exploration expenditure accounted for about 44 percent in 2015-2016, an increase of about 47 percent from 2014-2015. Base metals accounted for 19 percent in 2015-2016, a decrease of about 16 percent from 2014-2015. Uranium accounted for about 3 percent in 2015-2016, relatively unchanged from 2014-2015. Heavy-mineral sands accounted

for about 2 percent in 2015-2016, relatively unchanged from 2014-2015. Other minerals (including construction materials, tin, and tungsten) accounted for about 9 percent in 2015-2016, a decrease of about 10 percent from 2014-2015. ABS data suggest that new deposits accounted for about 29 percent of the total exploration budget for Australia in 2016 based on expenditures and existing deposits accounted for about 71 percent of expenditures.

In terms of number of meters drilled for mineral exploration, the ABS reported that about 6 million meters were drilled in fiscal year 2014-2015 and 6.4 million meters were drilled in fiscal year 2015-2016, an increase of 7 percent. This was the first increase reported since 2011-2012. The 2015-2016 data suggest that about 24 percent of the drilling took place on new projects and about 76 percent took place on existing deposits. The Western Australia Department of Mines and Petroleum reported that the number of exploration licenses for minerals and coal in Western Australia decreased by about 10 percent from the 2014-2015 fiscal year to the 2015-2016 fiscal year while the area covered by these licenses declined 16 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 order of Australian states with the greatest number of exploration sites were Western Australia (263), Queensland (50), Northern Territory (39), New South Wales (37), South Australia (25), Victoria (10) and Tasmania (8). Activity in 2016 was used to further define early-stage discoveries (63 percent), conduct exploration at a producing site (22 percent), conduct prefeasibility and feasibility studies of economically promising prospects (11 percent), further explore for resources of deposits under development (3 percent) and projects placed on care and maintenance (1 percent).

Based on SNL data, junior companies accounted for the majority (40 percent) of the Australia exploration budget, followed by major companies (39 percent), intermediate companies (18 percent), and Governments and other types of companies (3 percent). All company types decreased in budget share from 2015 to 2016, with junior companies having the largest decrease of over 30 percent. Since the global economic downturn in 2008-2009, junior mining companies have found it more difficult to secure financing, so they have focused exploration expenditures on fewer projects or reduced the exploration budgets at individual projects.

The 2016-2017 budget for Australia included a provision for the four-year, A\$100 million (US\$73 million) Exploring for the Future initiative, which is intended to increase mineral exploration in northern Australia and increase competitiveness of the Australian minerals sector. The first project under the initiative commenced to map the electrical conductivity of Northern Territory in order to gain a better understanding of the location of mineral and energy resources.

The Queensland Parliament passed the Environmental Protection (Underground Water Management) and Other Legislation Amendment (EPOLA) Bill, requiring advanced mining projects to obtain an associated water license. The state government also set aside A\$500,000 (US\$360,000) for exploration in northwest Queensland and opened up tenders for the exploration of tenements in the region with known occurrences of copper, gold, lead and zinc.

The South Australian government has initiated a Plan for Accelerated Exploration (PACE) that was designed to allow South Australian companies to better access the global mining supply chain. The state government also announced plans to review its mining legislation and policies.

The Western Australian government committed A\$5.17 million (US\$3.8 million) in round 12 and A\$5.14 million (US\$3.7 million) in round 13 of its Exploration Incentive Scheme (EIS) in 2016. The EIS is a competitive program which offers up to a 50 percent refund up to a specified ceiling for selected exploration drilling projects. The state government also extended the magnetite royalty relief program for an additional three years. The government reported that during the last quarter of 2015, the state approved 97 percent of its mineral prospecting license applications within 65 days and 99 percent of its mineral exploration permit applications within 30 days, an improvement over prior years.

United States. Based on SNL data, the United States (U.S.) mineral exploration budget decreased by about 30 percent to about \$500 million in 2016 from \$717 million in 2015, representing about 7 percent of the estimated overall worldwide exploration budget for 2016. On the basis of data compiled for this review by the USGS, data were collected on 178 active exploration projects. The top 10 states in the U.S. with the greatest number of exploration sites were Nevada (76), Alaska (25), Arizona (20), Idaho (8), Utah (8), Colorado

(6), New Mexico (6), California (5), Montana (5) and Minnesota and Oregon (3 each). Most of these sites had prior exploration activity, suggesting that economic conditions were such that exploration companies continued prior exploration activity or reevaluated sites because of technological advancements or their proximity to recent discoveries or deposits with similar geology.

Approximately 61 percent of the deposits actively explored in 2016 in the U.S. contained gold, 32 percent contained base metals (primarily copper), 1 percent contained uranium, the remaining 6 percent was budgeted for the exploration of other minerals, based on the sites considered in the USGS compilation. Activity in 2016 was used to further define early-stage discoveries (79 percent), conduct exploration at a producing site (13 percent), further explore for resources of deposits under development (4 percent), conduct prefeasibility and feasibility studies of economically promising prospects (2 percent) and projects placed on care and maintenance (2 percent).

Based on SNL data, major companies accounted for the majority (60 percent) of the U.S. exploration budget, followed by junior companies (27 percent), and intermediate companies, government and other types of companies (13 percent). All company types decreased in budget share from 2015 to 2016, with junior companies having the largest decrease of more than 40 percent.

SNL data suggest that exploration drilling in the U.S. increased by about 6 percent in 2016 from the level in 2015, based on the number of holes drilled. The level of drilling increased significantly near the end of the year; SNL data suggested that 42 percent of the exploration drilling took place in the fourth quarter of 2016.

A U.S. Government Accountability Office (GAO) report released in 2016 determined that from 2010-2014, the Bureau of Land Management and the U.S. Forest Service approved 68 mine plans of operation. The average approval time per site was approximately two years; however, as of Nov. 2016, 13 operations had yet to commence production. The GAO attributed the additional delay to technical difficulties and further permitting requirements. During the past decade, the permitting time for a new mine in the United States was seven to 10 years, longer than in Australia, Canada and Chile.

The Nevada Division of Minerals reported that the exploration budget for minerals in Nevada in 2016 was expected to be \$334.5 million. Based on budget data reported by the

Nevada Division of Minerals, precious metals accounted for about 92 percent of the 2016 exploration budget. Based on the number of active exploration sites reviewed by the USGS, however, exploration for precious metals in Nevada represented about 57 percent of projected mineral exploration activity. The principal exploration objectives in Nevada continued to be gold and silver, however exploration activity increased significantly for lithium (with 28 active sites in 2016). Exploration companies searched for resources sufficient to supply the newly opened Tesla Motors lithium-ion battery plant in Nevada, which Tesla estimated would require the equivalent of current world production of lithium to meet its projected capacity of 500,000 cars per year. Although the supply chain for battery components is primarily sourced in Asia, Tesla established a number of potential agreements with U.S. and Mexican suppliers of lithium for use in its batteries. Other companies were fast-tracking exploration of properties in Nevada as potential sources of supply to the new facility, which was expected to be completed in 2017.

In 2016, approximately 188,000 mining claims in Nevada were considered active, an increase from about 172,000 claims in 2015. Plans have been submitted to the U.S. Department of Interior for limiting exploration and mining on selected Federal land in Idaho, Montana, Nevada, Oregon and Wyoming to protect the habitat of the sage grouse. The magnitude of the mining ban will be determined by the Trump administration.

Based on a 2016 report released by the Alaska Department of Natural Resources, Alaskan exploration expenditures (excluding development projects) decreased about 39 percent to about \$58.3 million in 2015 from \$96.2 million spent in 2014. About 54 percent of the state's exploration spending in 2015 was conducted in areas adjacent to major mines. About 37 percent of the total estimated exploration expenditure for 2015 was spent exploring for gold veins, 35 percent for massive sulfide deposits, 17 percent for porphyry deposits, and 11 percent for intrusive gold deposits. About 46 percent of this expenditure was for precious metals, 43 percent for polymetallic deposits containing base and precious metals, and 11 percent for base metals. In 2015, approximately 6,100 federal and 42,000 state mining claims were active. Actual data for 2016 were unavailable although the exploration expenditures in Alaska were thought to be lower than the \$58 million expended in 2015.

The USGS conducted a hyperspectral survey in the search for copper deposits in remote locations of Alaska. It also conducted a magnetometer survey to detect copper, gold, iron and rare-earth deposits in the St. Francois Mountains of Missouri.

A two-year injunction prohibiting 30,000 acres of mining claims in Montana north of Yellowstone National Park was approved by the U.S. Department of the Interior. The Bureau of Land Management issued a preferred resource management plan in 2016 that would open acreage in interior Alaska to mining while creating conservation areas.

The Wyoming State Geological Survey published a report on the occurrence and distribution of REE in the state. Samples collected from this study were to be placed in the Wyoming Database of Geology, expected to be available online in early 2017.

Pacific/S.E. Asia. Based on SNL data, the Pacific and Southeast Asia region (excluding Australia) mineral exploration budget decreased by about 14 percent to about \$370 million in 2016 from \$429 million in 2015, which represented about 5 percent of the estimated overall worldwide exploration budget for 2016. Indonesia, Papua New Guinea, and the Philippines together accounted for about 76 percent of the total mineral exploration budget for the region. 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 Indonesia (28), Philippines (24), Papua New Guinea (23), Fiji (8), New Zealand (8), Cambodia (7), Thailand (7), Republic of Korea (5), Laos (4) and Malaysia (4). Indonesia, Philippines and Papua New Guinea together accounted for about 60 percent of the active exploration sites in the region in 2016.

Approximately 55 percent of the deposits actively explored in 2016 in the Pacific/S.E. Asia region contained gold, 32 percent contained base metals, with minor exploration activity for iron ore and other minerals. Activity in 2016 was used to further define early-stage discoveries (50 percent), conduct exploration at a producing site (36 percent), conduct prefeasibility and feasibility studies of economically promising prospects (10 percent), further explore for resources of deposits under development (2 percent) and projects temporarily suspended (2 percent).

Based on SNL data, major companies accounted for the majority (45 percent) of the Pacific/S.E. Asia exploration budget, followed

by intermediate companies (23 percent), junior companies (22 percent), and governments and other types of companies (10 percent). Majors were the only company type that increased in share from 2015 to 2016, all other company types declined.

Much of the sustained interest in this region can be attributed to the continued interest by Chinese and Korean companies to expand sources of supply for gold, base metals, and REE; Japanese companies interested in developing regional copper and nickel deposits to supply Japan's smelting industry; and interest in reducing the effects of the Indonesia ban on unprocessed mineral exports.

Ocean Minerals LLC has secured an exclusive agreement to conduct deep-sea exploration in the Pacific Ocean near the Cook Islands. The company was exploring for economically viable alternative sources of REE and scandium.

Indonesia was reviewing and revising legislation 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 being modified as of December 2016 to be limited to unprocessed gold, silver, tin and chromium, and may include nickel and bauxite. The government was considering the export of mineral concentrates if they meet certain conditions (obtain special mining license, pay export taxes and build smelters within five years). The regulatory uncertainty in Indonesia has contributed to the decision by Newmont Mining to sell its gold assets in Indonesia.

Malaysia implemented a moratorium on bauxite mining in 2016 and lifted a temporary ban on issuing bauxite export permits to expedite the clearing of bauxite stockpiles at the port of Kuantan. The moratorium will likely be extended if the bauxite stockpiles of 4.13 million st were not cleared by the end of 2016.

The Philippines became the largest exporter of nickel ore to China after Indonesia implemented a ban on unprocessed minerals in 2014. Since the 2016 Philippine presidential election, an audit of the country's mines was implemented. The audit resulted in the suspension of 10 mines and 20 additional mining units have been targeted for suspension. As of 2015, about 56 percent of the country's nickel production has been attributed to mining units suspended or targeted for suspension. Uncertainty of Indonesian nickel production has contributed to the rise in the nickel price throughout 2016 and resulted in a 60 percent

decrease in mineral exploration activity in Indonesia since 2014.

The Thailand government stopped issuing and renewing gold mining and exploration licenses in May 2016, resulting in the suspension of production at the Chatree gold mine and stopping mineral exploration in the country.

Rest of the World. Based on SNL data, the Rest of the World regional mineral exploration budget decreased by about 24 percent to about \$1.3 billion in 2016 from \$1.7 billion in 2015, representing about 19 percent of the estimated overall worldwide exploration budget for 2016. Exploration in China and Russia accounted for about 56 percent of the exploration budget for countries in Asia, the Commonwealth of Independent States (CIS), Europe, and the Middle East in 2016. China accounted for about 6 percent of the global exploration budget in 2016 and Russia accounted for about 5 percent. On the basis of data compiled for this review by the USGS, the top 10 Rest of the World countries with the greatest number of exploration sites were Russia (77), China (53), Kazakhstan (23), Turkey (23), India (19), Finland (18), Sweden (18), Serbia (12), Mongolia (11) and Portugal (9).

Approximately 43 percent of the deposits actively explored in 2016 of the Rest of the World region contained gold or silver, 28 percent contained base metals, 10 percent contained iron ore, and 19 percent contained other minerals, based on the sites considered in the USGS compilation. Selected regions within the ROW reported exploration activity as follows: CIS focused on gold or silver (59 percent), base metals (13 percent), iron ore (8 percent) and other minerals (20 percent). European mineral exploration primarily focused on gold or silver (43 percent), base metals (35 percent) and other minerals (22 percent). Middle Eastern exploration primarily focused on other minerals (40 percent), gold (33 percent) and base metals (27 percent). Activity in 2016 of the composite region was primarily used to conduct exploration at producing sites (42 percent), further define early-stage discoveries (41 percent), conduct prefeasibility and feasibility studies of economically promising prospects (9 percent), and further explore for resources of deposits under development (8 percent). In terms of commodity-based exploration activities, 2016 activity remained at the 2015 level.

Based on SNL data, major companies accounted for the majority (57 percent) of the

Rest of the World exploration budget, followed by junior companies (13 percent), intermediate companies (11 percent), and governments and other types of companies (19 percent). All company types decreased in budget share from 2015 to 2016, with junior companies having the largest decrease of more than 30 percent.

The 29 countries involved in the Antarctic Treaty, which bans mining in the Antarctic, agreed on a resolution that will keep this ban in effect until 2048.

China announced that within the next five years, exploration programs will be launched that include both deep sea and space-born earth observation. These programs were intended to identify underexplored areas that contain potential resources. Deep sea bed exploration in the Indian and Pacific Oceans with potential for massive sulfide deposits that could contain copper, zinc and precious metals are being explored as scientists work to improve techniques for mineral extraction. For domestic gold exploration, China has expressed interest in developing improved technologies to explore for gold at depth. In June, Chinese foreign investment rules were modified to allow international companies to create mining subsidiaries within free trade zones. With these modifications, the Chinese government allowed foreign companies to waive pre-approval requirements. The relaxed rules were put in place in order to make mining investment more attractive.

The Chinese government was working towards restructuring the REE industry through research and development. Restructuring was necessary to improve output where smaller projects were operating at a loss.

The Geological Survey of India (GSI) reported that 102,815 m were drilled during 2015-2016 for targets that include iron ore, manganese and REE. The Indian government created the National Geoscience Data Repository (NGDR) under the GSI along with the National Center for Mineral Targeting (MCMT). The mission of the NGDR and MCMT were to develop tools within geographic information systems (GIS) for mineral exploration reporting and data display.

In India, the National Minerals Exploration Policy was approved in efforts to stimulate mineral exploration. Through this policy, baseline geodata will be available in the public domain, and private companies were now allowed to bid on mineral exploration blocks.

After the U.S. and other countries lifted sanctions on Iran that were imposed in 2012, Iran opened more than \$29 million in mining

projects to foreign investors from China, and select European countries. Foreign investment was targeting aluminum, copper, gold, REE and titanium projects. In 2016, the USGS published a circular discussing the trends to the nonfuel mineral industry in Iran. This report included discussion on reserves and resources, operational mines and their respective capacity, commodity production and a general commodity review.

Russia has released state-owned geological data to the public in order to attract mineral exploration investment. Modifications of laws have been passed to allow junior miners to stake claims. Previously, discovered deposits would have been auctioned, and the explorers would not be allowed to retain ownership of their discovery.

Saudi Arabia's Energy Minister stated that investment in mineral exploration was expected to increase to \$500 million by the year 2020 from a baseline of \$50 million. There were plans to issue new exploration licenses as well for the development of key infrastructure. In an effort to reduce the country's reliance on oil, the King of Saudi Arabia opened a new \$35 billion mining hub.

The United Arab Emirates (UAE) Minister of Energy stated the country was in the early stages of introducing the first federal mining law in hopes of drawing investment into the industry. This legislation will aid in reducing the country's dependence of oil and diversifying the resource options for the UAE. ■

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, Nick Karl, U.S. Geological Survey, National Minerals Information Center, PO Box 25046, MS 750, Denver Federal Center, Denver, CO 80225-0046; telephone 303-236-5206; fax 303-236-4208 or nkarl@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; telephone 703-648-4920 or sfortier@usgs.gov. ■