

# Recent Trends in the Nonfuel Minerals Industry of Iran



Circular 1421

**Cover.** Ore extraction and processing capacity expansion projects are under development at the Sar Cheshmeh open pit mine, Iran's largest copper mine. Photograph by Gavin Doyle, South Africa.

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By Sinan Hastorun, Karine M. Renaud, and Graham W. Lederer

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**U.S. Department of the Interior**  
**U.S. Geological Survey**

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U.S. Geological Survey, Reston, Virginia: 2016

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Suggested citation:

Hastorun, Sinan, Renaud, K.M., and Lederer, G.W., 2016, Recent trends in the nonfuel minerals industry of Iran: U.S. Geological Survey Circular 1421, 18 p., <http://dx.doi.org/10.3133/cir1421>.

ISSN 1067-084X (print)  
ISSN 2330-5703 (online)

ISBN 978-1-4113-4066-4

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## Conversion Factors

International System of Units to Inch/Pound

<b>Multiply</b>	<b>By</b>	<b>To obtain</b>
	<b>Area</b>	
square kilometer (km <sup>2</sup> )	247.1	acre
square kilometer (km <sup>2</sup> )	0.3861	square mile (mi <sup>2</sup> )
	<b>Mass</b>	
gram (g)	0.03527	ounce, avoirdupois (oz)
kilogram (kg)	2.205	pound avoirdupois (lb)
metric ton (t)	1.102	ton, short [2,000 lb]
metric ton (t)	0.9842	ton, long [2,240 lb]

## Datum

Horizontal coordinate information is referenced to the World Geodetic System 1984 (WGS84).

## Abbreviations

CIDCO	Cement Investment and Development Company
DRI	direct-reduced iron
EAF	electric arc furnace
FKCC	Fars & Khuzestan Cement Company
FTZ	free trade zone
GDP	gross domestic product
g/t	gram per metric ton
Gt	billion metric ton
IMIDRO	Iran Mines and Mining Industries Development Renovation Organization
IRALCO	Iranian Aluminum Co.
K.D.D.	Karoun Dez Dasht
JCPOA	Joint Comprehensive Plan of Action
MENA	Middle East and North Africa
MIDHCO	Middle East Minerals Industries and Mines Development Holding Co.
MKM	Mansfelder Kupfer und Messing GmbH
Mt	million metric ton
Mt/yr	million metric ton per year
NICICO	National Iranian Copper Industries Co.
PKP	Pars Kohan Diarparsian Steel
SKS	Kish South Kaveh Steel Co.
SX–EW	solvent extraction–electrowinning
t	metric ton
t/yr	metric ton per year



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## Introduction

On January 16, 2016, President Obama announced that the United States would lift nuclear-related “secondary sanctions” on transactions by foreign persons and entities involving Iran that took place outside of U.S. jurisdiction in accordance with the “Joint Comprehensive Plan of Action (JCPOA)” signed in July 2015. Prior to the “Implementation Day” of January 16, 2016, U.S. nuclear sanctions imposed on Iran’s minerals industry had prohibited foreign investment and trade in petroleum, refined petroleum products, coal, gold and other precious metals, graphite, and raw or semifinished metals such as aluminum and steel (U.S. Department of the Treasury, 2016, p. 1–2). Following Implementation Day, the vast majority of U.S. sanctions on Iran remain in place and Iran’s minerals industry remains closed to American companies<sup>2</sup> (White House, 2016). This Circular provides information on Iran’s current supply of, and future mineral extraction and processing projects for, those nonfuel mineral commodities whose output levels may substantially change in the near future.

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<sup>1</sup>This Circular is for informational purposes only and reflects publicly available information collected by the U.S. Geological Survey, National Minerals Information Center. No portion of this Circular is intended to be or should be interpreted as promoting any business or trade opportunities with regard to or inside Iran. Any use of trade names is for descriptive purposes only and does not imply endorsement in any way by the U.S. Government.

<sup>2</sup>U.S. persons/organizations should consult with the U.S. Department of Treasury Office of Foreign Assets Control (<https://www.treasury.gov/resource-center/sanctions/Programs/Pages/iran.aspx>) to understand the U.S. sanctions regime before pursuing any business or activity in/with Iran.

## Mineral Resources and Reserves

The geology of Iran consists of a complex tectonic framework within the broader Alpine-Himalayan orogenic belt and hosts deposits of more than 68 fuel and nonfuel mineral commodities (Press TV, 2015c). Metallic mineral resources occur predominantly within igneous and metamorphic rocks of the Tethyan Eurasian Metallogenic Belt, particularly along the Urumieh-Dokhtar Magmatic Belt that trends northwest-southeast between the Central Iranian and Sanandaj-Sirjan Terranes in Eşfahān, Hamadān, Kermān, Markazī, Yazd, and Zanjān Provinces (fig. 1; Ghorbani, 2013, p. 243–249; Zürcher and others, 2015, p. 4–5). The Government-run Iranian Mines and Mining Industries Development and Renovation Organization (IMIDRO) planned to identify new nonfuel mineral deposits—in particular, those of bauxite, copper, gold, iron ore, rare-earth elements, and zinc (Iranian Mines and Mining Industries Development and Renovation Organization, 2015a; Karbasian, 2015, p. 3–6). Prospecting efforts would initially focus on an area of 44,800 square kilometers (km<sup>2</sup>) in six zones extending from Ābādeh in Fārs Province to Jāzmūrān near Sīstān va Balūchestān Province for chromium, copper, iron ore, and titanium (Press TV, 2015b). The new exploration program would eventually expand to 240,000 km<sup>2</sup> of territory within 12 Provinces (Press TV, 2015d) running from Bostānābād in Āzārbāyjān-e Sharqī Province in the northwest to Sarāvān in Sīstān va Balūchestān Province in the southeast over the next decade. By comparison, a total area of 100,000 km<sup>2</sup> had been explored in Iran in the 20th century (Karbasian, 2015, p. 6; Press TV, 2015b, c, d).

The U.S. Geological Survey (2016, p. 31, 61, 63, 77, 91) estimated that Iran held globally significant reserves of feldspar (2d largest in the world), barite (5th largest), gypsum (5th largest), fluor spar (8th largest), and iron ore (10th largest). According to the Government of Iran, nonfuel mineral ore reserves (proven, probable, and possible) were as follows: copper ore, 4.2 billion metric tons (Gt), of which 1.9 Gt were reportedly proven reserves (Samaneh Kansar Zamnin Co., 2013;

## 2 Recent Trends in the Nonfuel Minerals Industry of Iran



**Figure 1.** Locations of select key operating mines and nonfuel mineral processing facilities in Iran.

Iran Daily, 2015); iron ore, 2.7 Gt; bauxite and aluminum sources, 1.2 Gt; kaolin, 100 million metric tons (Mt); phosphate rock, 16.5 Mt; zinc, 11 Mt; barite, 10 Mt; manganese, 9.7 Mt; chromium, 8.5 Mt; and gold, 340 metric tons (t) (Iranian Mines and Mining Industries Development and Renovation Organization, 2015a, p. 11; Press TV, 2015a; Sharma, 2015).

### Minerals in the National Economy

Iran's nominal gross domestic product (GDP) was \$425.3 billion in 2014, making Iran the third largest economy in the Middle East and North Africa (MENA) region after

Turkey and Saudi Arabia. The country had an extensive mineral production and processing industry that produced more than 40 mineral commodities. Major nonfuel mineral commodities produced by Iran are shown in table 1. Mining accounted for less than 1 percent of the country's GDP, whereas mineral processing, of which aluminum, cement, copper, and steel production were significant components, contributed an additional 4 percent of GDP in 2014. IMIDRO planned to double the contribution of mining and quadruple that of mineral processing within the next decade (Central Bank of the Islamic Republic of Iran, 2015, p. 2; Iran International Magazine, 2015, p. 29; Trade Arabia, 2015; World Bank, 2015).

**Table 1.** Key mines and nonfuel mineral facilities in Iran including major development and expansion projects.

[Annual capacities in thousand metric tons unless otherwise noted; current capacities as of most recent reference cited. Planned facilities, denoted by (\*), do not appear on the map (fig. 1). e, estimated; IMIDRO, Iranian Mines and Mining Industries Development and Renovation Organization; kg, kilogram; NA, not available; =, unchanged; —, not applicable]

Commodity	Facility name	Facility type	Major operating companies and major equity owners	Province	Annual capacity		Capacity reference
					Current	Planned	
Bauxite, alumina, and aluminum							
Bauxite	Jajarm	Mine	Iran Alumina Co. (IMIDRO)	Khorāsān-e Shomālī	800	=	National Geoscience Database of Iran, undated
Alumina	Arak	Refinery*	Iran Alumina Co. (IMIDRO)	Markazī	—	2,000	Sharma, 2015
Alumina	Jajarm	Refinery	Iran Alumina Co. (IMIDRO)	Khorāsān-e Shomālī	280	=	Iran International Magazine, 2003
Alumina	Asaluyeh	Refinery*	Sinosteel Equipment & Engineering Co. Ltd.	Būshehr	—	1,600	Tasnim News Agency, 2016a
Alumina	Sarab	Refinery*	Iran Alumina Co. (IMIDRO)	Āzārbāyjān-e Sharqī	—	200	Iran Daily, 2014
Aluminum	Arak	Smelter	Iranian Aluminum Co. (IMIDRO)	Markazī	230	=	Iran International Magazine, 2015
Aluminum	Bandar Abbas	Smelter	Almahdi Aluminum Co. (IMIDRO)	Hormozgān	257	500	Iran International Magazine, 2015; Karbasian, 2015
Aluminum	Asaluyeh	Smelter*	Sinosteel Equipment & Engineering Co. Ltd.	Būshehr	—	350	Tasnim News Agency, 2016a
Aluminum	Chabahar	Smelter*	National Aluminum Co.	Sīstān va Balūchestān	—	500	Karbasian, 2015
Aluminum	Jajarm	Smelter*	Iran Alumina Co. (IMIDRO)	Khorāsān-e Shomālī	—	110	Karbasian, 2015
Aluminum	Lamerd	Smelter*	South Aluminum Co. (Ghadir Investment Co., IMIDRO)	Fārs	276	500	Karbasian, 2015
Aluminum	Masjed Soleyman	Smelter*	Kaveh Khozestan Aluminium Co.	Khūzestān	—	375	Iran International Magazine, 2015
Cement							
Cement	Abyek	Plant	Abyek Cement Co. (Fars & Khuzestan Cement Co.)	Qazvīn	3,900	=	Intercecm Doha, 2015
Cement	Khuzestan	Plant	Khuzestan Cement Co. (Fars & Khuzestan Cement Co.)	Khūzestān	2,500	=	Intercecm Doha, 2015
Cement	Sepahan	Plant	Sepahan Cement Co. (Ghadir Investment Co.)	Eṣfahān	3,100	=	Intercecm Doha, 2015
Cement	Tehran	Plant	Tehran Cement Co.	Tehrān	3,200	=	Intercecm Doha, 2015
Copper							
Copper concentrate	Miduk	Mine	National Iranian Copper Industries Co. (IMIDRO)	Kermān	150	=	International Copper Study Group, 2015
Copper concentrate	Sarcheshmeh	Mine	National Iranian Copper Industries Co. (IMIDRO)	Kermān	640	800	International Copper Study Group, 2015
Copper concentrate	Sungun	Mine	National Iranian Copper Industries Co. (IMIDRO)	Āzārbāyjān-e Sharqī	300	=	International Copper Study Group, 2015

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**Table 1.** Key mines and nonfuel mineral facilities in Iran including major development and expansion projects.—Continued

[Annual capacities in thousand metric tons unless otherwise noted; current capacities as of most recent reference cited. Planned facilities, denoted by (\*), do not appear on the map (fig. 1). e, estimated; IMIDRO, Iranian Mines and Mining Industries Development and Renovation Organization; kg, kilogram; NA, not available; =, unchanged; —, not applicable]

Commodity	Facility name	Facility type	Major operating companies and major equity owners	Province	Annual capacity		Capacity reference
					Current	Planned	
Copper—Continued							
Copper concentrate	Chah Firouzeh	Mine*	National Iranian Copper Industries Co. (IMIDRO)	Kermān	—	100	International Copper Study Group, 2015
Copper, anode	Khatoonabad	Smelter	National Iranian Copper Industries Co. (IMIDRO)	Kermān	80	120	International Copper Study Group, 2015
Copper, anode	Sarcheshmeh	Smelter	National Iranian Copper Industries Co. (IMIDRO)	Kermān	145	280	International Copper Study Group, 2015
Copper, cathode	Sarcheshmeh	Refinery	National Iranian Copper Industries Co. (IMIDRO)	Kermān	240	=	International Copper Study Group, 2015
Copper, cathode	Khatoonabad	Refinery*	National Iranian Copper Industries Co. (IMIDRO)	Kermān	—	200	International Copper Study Group, 2015
Copper, cathode	Miduk	SX–EW	National Iranian Copper Industries Co. (IMIDRO)	Kermān	5	=	International Copper Study Group, 2015
Copper, cathode	Sarcheshmeh	SX–EW	National Iranian Copper Industries Co. (IMIDRO)	Kermān	12	=	International Copper Study Group, 2015
Copper, cathode	Sungun	SX–EW*	National Iranian Copper Industries Co. (IMIDRO)	Āzārbāyjān-e Sharqī	3	53	International Copper Study Group, 2015
Gold							
Gold (kg)	Agh Darreh	Mine	Pooya Zarcan Agh Darreh	Āzārbāyjān-e Gharbī	2,200	=	Mehr News Agency, 2014
Gold (kg)	Muteh	Mine	Iran Minerals Production and Supply Co. (IMIDRO)	Eṣfahān	300	=	Iran Minerals Production and Supply Co., 2015b
Gold (kg)	Sari Gunay	Mine	Zar Kuh Mining Co.	Kordestān	2,000	=	Press TV, 2015f
Gold (kg)	Zarshouran	Mine	IMIDRO	Āzārbāyjān-e Gharbī	3,000	6,000	Iran International Magazine, 2015
Iron and steel							
Iron ore	Chadormalu	Mine	Chadormalu Mining & Industrial Co. (National Iranian Steel Co., IMIDRO)	Yazd	16,000	=	Iran International Magazine, 2015
Iron ore	Choghart	Mine	Iran Central Iron Ore Co. (National Iranian Steel Co., IMIDRO)	Yazd	3,250	6,200	Iran Central Iron Ore Co., undated; Iran International Magazine, 2001
Iron ore	Gol-e-Gohar	Mine	Gol-e-Gohar Iron Ore Co. (National Iranian Steel Co., IMIDRO)	Kermān	7,000	=	Iran International Magazine, 2015
Iron ore	Jalal Abad	Mine	Iran Minerals Production and Supply Co. (IMIDRO)	Kermān	2,000	4,000	Iran Daily, 2012
Iron ore	Sangan	Mine	Sangan Iron Ore Co. (National Iranian Steel Co., IMIDRO)	Khorāsān-e Razavī	2,600	5,000	IMIDRO, 2012
Iron ore pellets	Persian Metallics	Plant*	Danieli Group, Butia Iranian Steel Co.	Sīstān va Balūchēstān	—	6,000	Moggridge, 2016a

**Table 1.** Key mines and nonfuel mineral facilities in Iran including major development and expansion projects.—Continued

[Annual capacities in thousand metric tons unless otherwise noted; current capacities as of most recent reference cited. Planned facilities, denoted by (\*), do not appear on the map (fig. 1). e, estimated; IMIDRO, Iranian Mines and Mining Industries Development and Renovation Organization; kg, kilogram; NA, not available; =, unchanged; —, not applicable]

Commodity	Facility name	Facility type	Major operating companies and major equity owners	Province	Annual capacity		Capacity reference
					Current	Planned	
Iron and steel—Continued							
Iron ore pellets	NA	Plant*	KIOCL Ltd.	NA	—	1,100	Das and Serapio, 2016
Iron, direct-reduced	Hormozgan	Plant	Hormozgan Steel Co. (National Iranian Steel Co., IMIDRO)	Hormozgān	1,500	3,000	Havasi, 2016
Iron, direct-reduced	Khouzestan	Plant	Khouzestan Steel Co. (National Iranian Steel Co., IMIDRO)	Khūzestān	4,000	=	Khouzestan Steel Co., undated
Iron, direct-reduced	Mobarakeh	Plant	Mobarakeh Steel Co. (National Iranian Steel Co., IMIDRO)	Eşfahān	5,000	=	Mobarakeh Steel Co., undated
Steel, crude	Esfahan	Plant	Esfahan Steel Co. (National Iranian Steel Co., IMIDRO)	Eşfahān	3,600	4,200	Iran International Magazine, 2015
Steel, crude	Khouzestan	Plant	Khouzestan Steel Co. (National Iranian Steel Co., IMIDRO)	Khūzestān	3,600	=	Khouzestan Steel Co., undated
Steel, crude	Kish South Kaveh	Plant	Kish South Kaveh Steel Co.	Hormozgān	1,200	2,400	Moggridge, 2016b
Steel, crude	Mobarakeh	Plant	Mobarakeh Steel Co. (National Iranian Steel Co., IMIDRO)	Eşfahān	5,400	=	Iran International Magazine, 2015
Steel, crude	Arvand	Plant*	Arvand Jahanara Steel Co., Kish South Kaveh Steel Co., United Steel Industrial Co.	Khūzestān	—	5,000	Financial Tribune, 2015c
Steel, crude	Chabahar	Plant*	Pars Kohan Diaparsian Steel, POSCO	Sīstān va Balūchestān	—	1,600	Jin, 2016
Steel, crude	Persian Metallics	Plant*	Danieli Group, Butia Iranian Steel Co.	Sīstān va Balūchestān	—	1,500	Financial Tribune, 2016b
Steel, crude	Qeshm	Plant*	Qeshm Steel Mills (IMIDRO)	Hormozgān	—	1,600	Karbasiyan, 2015
Lead and zinc							
Lead concentrate	Dandi	Plant	Calcimin Co. (Iran Zinc Mine Development Co., IMIDRO)	Zanjān	30	=	Iran Zinc Mines Development Co., undated
Lead concentrate	Zanjan	Plant	Zanjan Zinc Kholes Sazan Industrial Group	Zanjān	20	=	Zanjan Zinc Kholes Sazan Industrial Group, 2016
Lead, refined	Zanjan	Refinery	National Iranian Lead & Zinc Co. (IMIDRO)	Zanjān	40	=	National Geoscience Database of Iran, undated
Lead and zinc ore	Angouran	Mine	Calcimin Co. (Iran Zinc Mine Development Co., IMIDRO)	Zanjān	1,000	=	Minews, 2015a

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**Table 1.** Key mines and nonfuel mineral facilities in Iran including major development and expansion projects.—Continued

[Annual capacities in thousand metric tons unless otherwise noted; current capacities as of most recent reference cited. Planned facilities, denoted by (\*), do not appear on the map (fig. 1). e, estimated; IMIDRO, Iranian Mines and Mining Industries Development and Renovation Organization; kg, kilogram; NA, not available; =, unchanged; —, not applicable]

Commodity	Facility name	Facility type	Major operating companies and major equity owners	Province	Annual capacity		Capacity reference
					Current	Planned	
Lead and zinc—Continued							
Lead and zinc ore	Emarat	Mine	Ber-Oner Tehran Co.	Markazī	150	=	Tete Mining, undated
Lead and zinc ore	Irakouh	Mine	Bama Co.	Eşfahān	100	=	Bama Co., undated
Lead and zinc ore	Koushk	Mine	Bafgh Mining Co.	Yazd	120	=	Hannam & Partners, 2015
Lead and zinc ore	Mehdi Abad	Mine	Mehdiabad Zinc Co. (K.D.D. Group)	Yazd	700e	6,000e	Minews, 2015d; IMIDRO, 2016
Zinc concentrate	Dandi	Plant	Calcimin Co. (Iran Zinc Mine Development Co., IMIDRO)	Zanjān	500	=	Iran Zinc Mines Development Co., undated
Zinc concentrate	Mehdi Abad	Plant	Mehdiabad Zinc Co. (K.D.D. Group)	Yazd	100	800	Minews, 2015d; IMIDRO, 2016
Zinc concentrate	Zanjan	Plant	Zangan Zinc Industry LLP (Iran Zinc Mine Development Co., IMIDRO)	Zanjān	250	=	Iran Zinc Mines Development Co., undated
Zinc concentrate	Zanjan	Plant	Zanjan Zinc Khales Sazan Industrial Group	Zanjān	200	=	Zanjan Zinc Khales Sazan Industrial Group, 2016
Zinc, refined	Bafgh	Refinery	Bafgh Zinc Smelting Co. (Iran Zinc Mine Development Co., IMIDRO)	Yazd	30	=	Iran Zinc Mines Development Co., undated
Zinc, refined	Dandi	Refinery	Calcimin Co. (Iran Zinc Mine Development Co., IMIDRO)	Zanjān	80	=	Iran Zinc Mines Development Co., undated
Zinc, refined	Zanjan	Refinery	Zanjan Zinc Khales Sazan Industrial Group	Zanjān	35	=	Zanjan Zinc Khales Sazan Industrial Group, 2016
Zinc, refined	Mehdi Abad	Refinery*	Mehdiabad Zinc Co. (K.D.D. Group)	Yazd	—	100	Tete Mining, undated

## Mineral Commodity Production

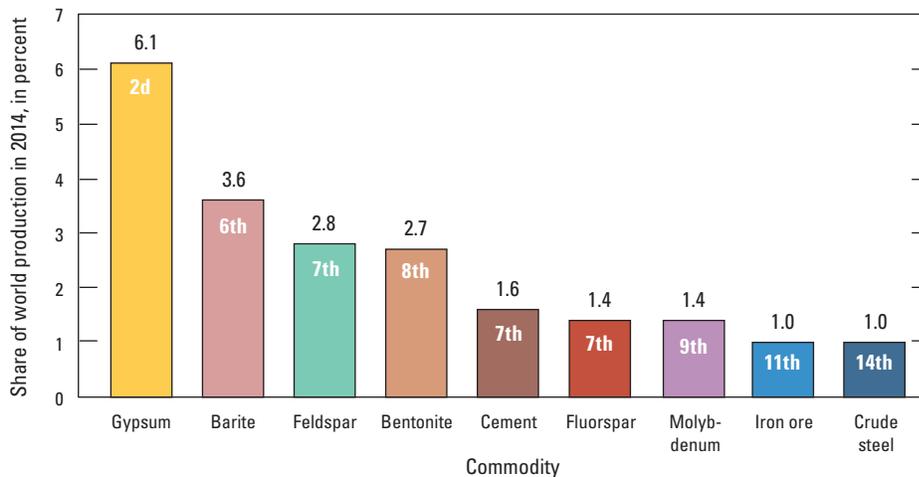
Iran ranked among the top 15 producers in the world for nine nonfuel mineral commodities in 2014. For gypsum and barite, the country's shares of world production were particularly significant, making it the 2d-leading producer of gypsum and the 6th-leading producer of barite, with 6.1 percent and 3.6 percent of world output, respectively. Iran was also the world's 7th-leading producer of cement, feldspar, and fluorspar; 8th-leading producer of bentonite; 9th-leading producer of molybdenum; 11th-leading producer of iron ore; and 14th-leading producer of crude steel (fig. 2; U.S. Geological Survey, 2016, p. 31, 45, 51, 61, 63, 77, 91, 113; World Steel Association, 2016). Within

the MENA region, Iran ranked first in output for copper (Reichl and others, 2016, p. 101), fluorspar, gypsum, iron ore, and molybdenum. It also ranked second after Morocco for barite and after Turkey for bentonite, cement, crude steel, feldspar, lead, and zinc. Iran was not a globally or regionally significant producer of alumina, aluminum, bauxite, or gold (Reichl and others, 2016, p. 101; Mowafa Taib, U.S. Geological Survey, unpub. data, 2016).

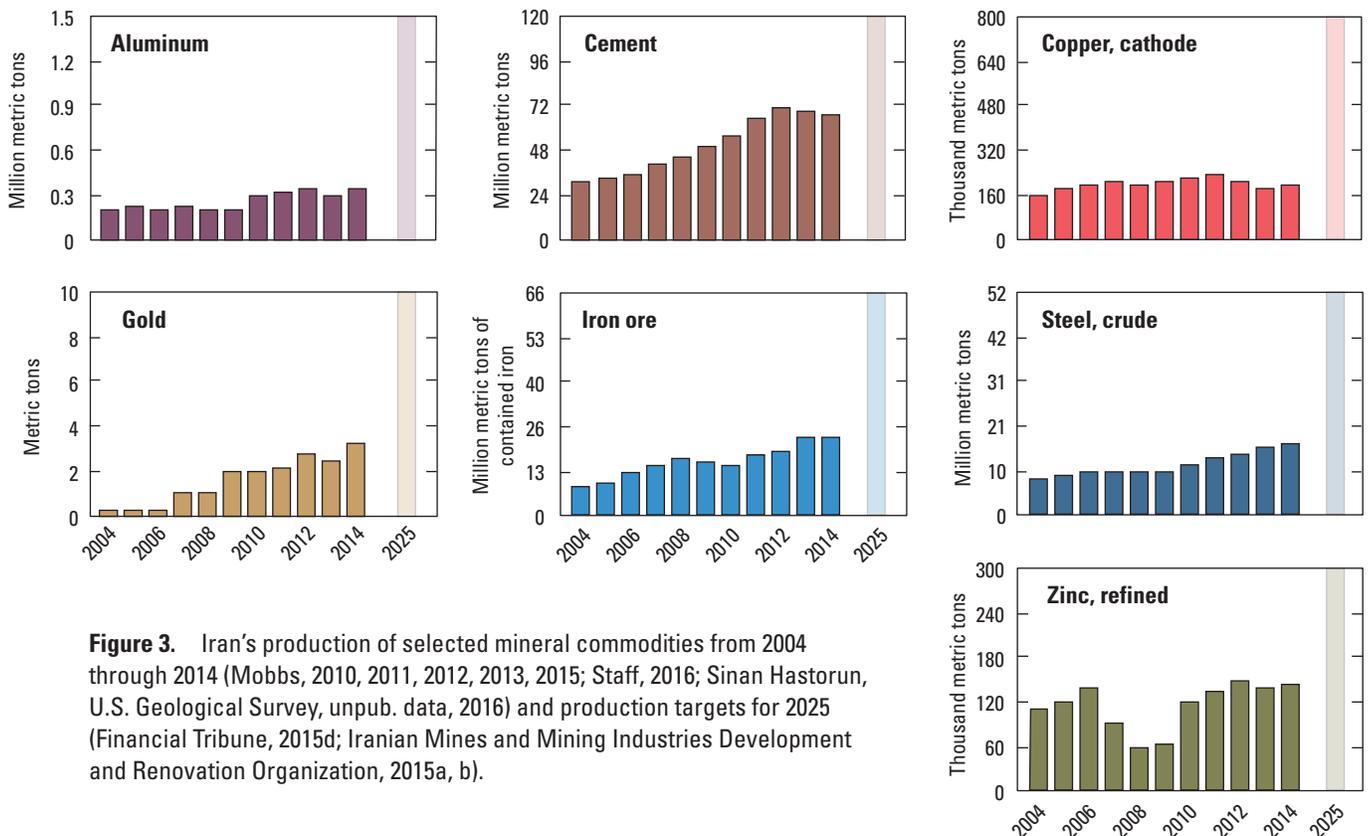
IMIDRO, which owns and operates most of the country's mines and mineral processing facilities, aims to substantially increase the volume of Iran's total mineral output to 200 Mt by 2025 (Iranian Mines and Mining Industries Development and Renovation Organization, 2015a, p. 13). As production levels for many industrial minerals were already relatively

high, output targets have been established primarily for metals (fig. 3). Accordingly, Iran plans to quadruple the output of aluminum, copper cathode, direct-reduced iron, and iron ore pellets; triple that of crude steel and gold; and double that of cement, pig iron, and zinc (Karbasian, 2014, p. 4; Financial Tribune, 2015d; Iranian Mines and Mining Industries Development and Renovation Organization, 2015a, p. 6). At levels envisioned by the Government, Iran would become the leading producer of nonfuel mineral commodities in the MENA region, but would still trail Algeria in zinc production, Egypt in gold, Turkey in steel,

and the United Arab Emirates in aluminum (Mowafa Taib, U.S. Geological Survey, unpub. data, 2016). Except for cement, gold, and iron ore, annual growth rates needed to reach the 2025 production targets significantly exceed those realized in the past decade, highlighting the substantial amount of investment into Iran’s minerals industry that would be required (table 2). The Government of Iran estimated funds required for building and upgrading mines and facilities to exceed \$29 billion, a substantial portion of which it hoped would be provided through foreign investment (Bloomberg, 2015; Financial Tribune, 2015c).



**Figure 2.** Iran’s share of world production and global ranking for selected mineral commodities in 2014 (U.S. Geological Survey, 2016; World Steel Association, 2016).



**Figure 3.** Iran’s production of selected mineral commodities from 2004 through 2014 (Mobbs, 2010, 2011, 2012, 2013, 2015; Staff, 2016; Sinan Hastorun, U.S. Geological Survey, unpub. data, 2016) and production targets for 2025 (Financial Tribune, 2015d; Iranian Mines and Mining Industries Development and Renovation Organization, 2015a, b).

**Table 2.** Iran's mineral output and average annual growth: actual and targeted.

[Mineral output in million metric tons unless otherwise specified. Sources: Mobbs (2010); Karbasian (2014); Financial Tribune (2015c); Iranian Mines and Mining Industries Development and Renovation Organization (2015a); Sinan Hastorun, U.S. Geological Survey, unpub. data (2016)]

Commodity	Mineral output		Annual growth (percent)	
	2014	2025	2004–2014	2015–2025
Aluminum	0.4	1.5	5	14
Cement	66.4	120	8	6
Copper, cathode <sup>1</sup>	194	800	2	14
Gold <sup>2</sup>	3.3	10	33	11
Iron ore, iron content	23.7	66.2	10	10
Steel, crude	16.3	52	7	11
Zinc, refined <sup>1</sup>	142	300	3	7

<sup>1</sup>Mineral output in thousand metric tons.

<sup>2</sup>Mineral output in metric tons.

## Mineral Commodity Review

### Bauxite, Alumina, and Aluminum

Iran was a minor producer of bauxite, alumina, and aluminum in the MENA region and globally in 2014 (Reichl and others, 2016, p. 141, 143; Mowafa Taib, U.S. Geological Survey, unpub. data, 2016). The country's production of bauxite decreased by 36 percent to 504,000 t and output continued to lag behind domestic demand from alumina and aluminum producers (fig. 3; Minews, 2015c). Iran Alumina Co., the only producer of bauxite and alumina in the country, operated the Jajarm Mine, Khorāsān-e Shomālī Province, the country's largest bauxite mine with estimated reserves of 10.6 Mt averaging 47 percent total available alumina (Ghorbani, 2013, p. 319). The mine supplied about 36 percent of Iran's annual domestic bauxite consumption, whereas imports, mostly from Guinea, accounted for the remaining 64 percent (Sharma, 2015). Iran Alumina Co. also operated a 280,000-metric-ton-per-year (t/yr) alumina refinery in Jājarm, which met about a quarter of annual domestic demand (table 1; Robinson, 2015). In 2014, alumina production increased by 3 percent to 252,000 t (fig. 3). During the year, Iran exported 47,300 t of alumina to Tajikistan for the first time and imported 135,100 t of alumina from China and India (Ministry of Industry, Mine, and Trade, 2014, p. 32, 34). In order to increase bauxite production, Iran Alumina Co. continued to explore deposits domestically in Kermān, Kohgīlūyeh va Bowyer Aḥmad, Semnān, and Yazd Provinces (Minews, 2015b) as well as abroad in Guinea through the recently renewed 4-million-metric-ton-per-year (Mt/yr) Societe des Bauxites de Dabola-Tougou project, which was 51 percent owned

by IMIDRO and 49 percent by the Government of Guinea (Islamic Republic News Agency, 2015). As of May 2016, IMIDRO was in the process of evaluating alternatives to transport bauxite from the inland mine to a port in Guinea, including the construction of a railway (Nasseri and Kalantari, 2016). In 2015, the company discovered deposits at the Ganou and Taash Mines in Semnān Province and was in the process of obtaining operating permits for mines in Kermān and Yazd Provinces (Iran International Magazine, 2015, p. 118). It planned to build a 2-Mt/yr capacity alumina refinery (from bauxite) in Arāk, Markazī Province, and a 200,000-t/yr alumina (from nepheline syenite) refinery in Sarāb, Āz̄arbāȳjān-e Sharqī Province (table 1; Iran Daily, 2014; Sharma, 2015). In March 2016, Sinosteel Equipment and Engineering Co. Ltd. of China announced plans to build a 1.6-Mt/yr alumina plant (formerly known as the Persian Gulf Alumina Project) to be supplied with imported bauxite from the Guinean project and an aluminum smelter with production capacity of 350,000 t/yr of aluminum ingots (table 1; Tasnim News Agency, 2016a).

Two companies produced primary aluminum in Iran: Iranian Aluminum Co. (IRALCO) and Almahdi Aluminum Co. (table 1). In 2014, total aluminum production increased by 20 percent from 2013 to 354,000 t (Iranian Mines and Mining Industries Development and Renovation Organization, 2014, p. 10; 2015a, p. 12; Sharma, 2015); however, the aluminum output in 2013 had been below the country's average annual output of about 320,000 t (fig. 3). Iran's aluminum output was the lowest among Persian Gulf countries (Bahrain, Oman, Qatar, Saudi Arabia, and United Arab Emirates) except for Kuwait, which did not produce aluminum. Despite Iran's abundant reserves of natural gas available for energy use, insufficient electricity generation as well as a shortage of bauxite input continued to prevent full utilization of the country's total aluminum capacity, which was 487,000 t/yr in 2015 (table 1; Sharma, 2015; Foundry-Suppliers.com, 2016; Nasseri and Kalantari, 2016). To reach the Government's 2025 target output of 1.5 Mt of aluminum, an average annual growth rate of 14 percent would be required starting in 2015, almost triple the 5 percent in the previous decade (table 2; fig. 3; Mottahedi and Mottahedi, 2012; Farge, 2013; Iran International Magazine, 2015, p. 20, 118). The target had been in place since 2000, but was unmet as a component of the 5th National Development Plan for 2010 through 2015 (Mottahedi and Mottahedi, 2012; Financial Tribune, 2015a). IMIDRO planned to achieve the goal through foreign investment of about \$10 billion and a commitment by the Government to supply electricity to new aluminum plants at fixed rates under long-term agreements. It also planned to increase domestic aluminum output to 770,000 t/yr by 2016 through expansion of the sector's total capacity (Farge, 2013) and to export 60 percent of output (Nasseri and Kalantari, 2016). Official plans included the expansion of Almahdi's Hormozgān smelter capacity from 110,000 t/yr to 257,000 t/yr (Iran International Magazine, 2015, p. 102) and the construction of two new smelters: a 110,000-t/yr smelter in Jājarm by Iran Alumina Co. and a 276,000-t/yr smelter in Lāmerd, Fārs Province,

by South Aluminum Co. (SALCO) (Karbasiyan, 2015, p. 5). Almahdi and SALCO planned to further increase the capacities of each smelter to 500,000 t/yr by 2025 (Karbasiyan, 2015, p. 5). Kaveh Khozestan Aluminium Co. was in the process of building an aluminum smelter with a 375,000-t/yr capacity in Masjed Soleyman, Khuzestan Province, through two phases (Hosseini and Moghadam, 2014; Iran International Magazine, 2015, p. 30). India's National Aluminum Co. was considering building a 500,000-t/yr aluminum smelter complex in Chabahar, Sistan va Baluchestan Province (table 1; Karbasiyan, 2015; Dash and Das, 2016).

## Cement

Iran was the second-leading cement producer in the MENA region after Turkey (U.S. Geological Survey, 2016, p. 45) and competed with the latter and Pakistan for the export markets of neighboring countries such as Iraq and Afghanistan (Kalb, 2014). In 2014, Iran's cement production decreased by 33 percent to 66.4 Mt after decreasing by 2 percent in 2013, owing largely to a continuing decline in domestic consumption and the resulting contraction of the construction sector since 2012 (fig. 3). Iran's cement consumption amounted to 54.0 Mt in 2014 compared with 55.6 Mt in 2013 and 57.6 Mt in 2012 (International Cement Review, 2015, p. 177). To reach the Government's 2025 target output of 120 Mt of cement, an average annual growth rate of 6 percent would be required starting in 2015 compared with 8 percent in the previous decade (table 2; fig. 3; Financial Tribune, 2015d). The cement sector faced challenges, such as reduced construction activity and an inadequate provision of natural gas to industrial users, which have prompted the idling of a portion of its capacity. A surplus stock of 17 Mt of clinker at yearend 2014 prompted a 30-day halt in production in January 2015 (Global Cement staff, 2015c). As of early 2016, 35 percent of total cement capacity remained inactive (Global Cement staff, 2016). Cement producers have increasingly focused on exports in recent years to compensate for falling demand. Iran was the leading global exporter of cement, shipping 19.4 Mt (including clinker) in 2014, primarily to countries in the Middle East and Central Asia (International Cement Review, 2015, p. 7). Iraq was the main recipient of exports of cement from Iran, receiving 51 percent, followed by Afghanistan, Kuwait, and Qatar (9 percent each); Turkmenistan (6 percent); and Pakistan (5 percent). The Government aimed to increase cement exports to 21 Mt/yr by 2017 and to 32 Mt/yr by 2025 (Financial Tribune, 2015d; Global Cement staff, 2015b, c; International Cement Review, 2015; Tajik, 2016).

There were 71 cement plants in Iran in 2015 with a combined capacity of 80.6 Mt/yr, including 64 grey cement plants and 7 white cement plants (International Cement Review, 2015, p. 177; Tajik, 2016). As of early 2016, utilized capacity of the cement sector amounted to 66 Mt/yr. The construction of 54 new plants with an additional capacity of 48.3 Mt/yr was planned (Global Cement staff, 2015a; Financial Tribune, 2015d). Of these, 10 plants were near

completion as of September 2015, with 8.3 Mt/yr of capacity expected to come online in 2016 (Tajik, 2016). Government-backed companies, including Fars & Khuzestan Cement Co. (FKCC), Tehran Cement Co., and Ghadir Investment Co., controlled 63 percent of the cement market by sales. FKCC, the leading cement producer, operated 17 plants with a total capacity of 24.8 Mt/yr, including the 3.9-Mt/yr Abyek plant, the largest in Iran (Intercem Doha, 2015). Tehran Cement, the second-leading cement producer, operated seven plants with a total capacity of 10.6 Mt, whereas Cement Investment and Development Co. (CIDCO) operated five plants with a total capacity of 8.1 Mt (table 1; International Cement Review, 2015, p. 176). The market share of privately owned companies continued to increase, reaching 37 percent in 2015 (Global Cement staff, 2015a, 2016; Tajik, 2016).

## Copper

Iran was the leading copper producer in the MENA region (Reichl and others, 2016, p. 144–145; Mowafa Taib, U.S. Geological Survey, unpub. data, 2016). In 2014, the country's production of copper concentrate increased by 5 percent to 790,000 t, copper anode by 4 percent to 232,500 t, and copper cathode by 3 percent to 194,000 t from those of 2013 (fig. 3). To reach the Government's 2025 target output of 800,000 t of copper cathode, an average annual growth rate of 14 percent would be required starting in 2015, a sevenfold increase compared with 2 percent registered in the previous decade (table 2; fig. 3; Iran International Magazine, 2015, p. 20; Iranian Mines and Mining Investment Development and Renovation Organization, 2015a, p. 13). In 2014, Iran exported 46,600 t and imported only 400 t of copper cathode (Ministry of Industry, Mine, and Trade, 2014, p. 33, 35).

National Iranian Copper Industries Co. (NICICO), the leading producer of copper in the country, operated the country's three major copper mines of Miduk, Sarcheshmeh, and Sungun, whose combined reserves (proven, probable, and possible) were estimated by an Iranian exploration study to be 2.6 Gt of ore containing 0.6 percent copper (table 1; Samaneh Kansar Zamnini Co., 2013). The company was in the process of increasing copper production through expansion of existing facilities in 2015. During the year, NICICO added about 300,000 t/yr to its total copper concentrate production capacity by commissioning two ore beneficiation units in Sarcheshmeh and Sungun. The capacity of the Sarcheshmeh copper complex increased by 160,000 t/yr of copper concentrate and 1,100 t/yr of molybdenum concentrate (National Iranian Copper Industries Co., 2015b), whereas that of the Sungun copper complex doubled to 300,000 t/yr of copper concentrate (Financial Tribune, 2015f; Ghale, 2015). NICICO planned to increase its output of copper concentrate from 251,000 t in 2015 to 300,000 t/yr in 2016 and to 400,000 t/yr by 2018 (International Mining, 2014; National Iranian Copper Industries Co., 2015a, b). The company was also in the process of building the 200,000-t/yr Khatoonabad refinery in Kerman Province, and the 50,000-t/yr Sungun solvent extraction–electrowinning

plant to produce copper cathodes (Burton, 2014; Iran International Magazine, 2015, p. 38). In addition to 42,500 t of copper concentrate, NICICO produced about 381 t of molybdenum concentrate and 53 t of sludge containing gold and silver in Sarcheshmeh in April 2014 (Minews, 2015e).

In October 2015, NICICO signed an investment agreement with the Middle East Mineral Industries and Mines Development Holding Co. (MIDHCO), Mahan Industries and Mines Development Corp., and Mofid Economic Group for the construction of the 100,000-t/yr Chah Firouzeh copper concentrator plant in Kermān Province, southwestern Iran. The plant, which would be 65-percent owned by the three privately owned companies, was expected to begin operating by 2019 (National Iranian Copper Industries Co., 2015a). In February 2016, NICICO signed a memorandum of understanding with Germany's Mansfelder Kupfer und Messing GmbH (MKM) on a \$1.1 billion investment in the development of downstream copper fabrication capacity in Iran and the delivery of 70,000 t/yr of copper cathode to MKM (National Iranian Copper Industries Co., 2016a). In April 2016, NICICO announced that owing to low prevailing global copper prices, it would scale back its plans to increase production to 700,000 t/yr of copper in concentrate in the near future; however, it still aimed to reach 420,000 t/yr by 2020. The company exported about 40 percent of its concentrate production in 2015 instead of processing it into cathode owing to relatively high labor costs that prevailed in domestic smelting and refining (National Iranian Copper Industries Co., 2016b).

## Gold

Iran was a minor producer of gold in the MENA region and globally, producing at levels substantially lower than those of Egypt, Saudi Arabia, and Turkey in 2014 (Reichl and others, 2016, p. 151–152; Mowafa Taib, U.S. Geological Survey, unpub. data, 2016). The country's production of gold increased by 32 percent from 2013 to about 3.3 t in 2014 (fig. 3). To reach the Government's 2025 target output of 10 t of gold, an average annual growth rate of 11 percent would be required starting in 2015, one-third of the 33 percent registered in the previous decade, when Iran's gold production had been very small (table 2, fig. 3; Iranian Mines and Mining Investment Development and Renovation Organization, 2015a, p. 13). IMIDRO planned to further increase production to 6 t/yr of gold in 2017 by commissioning the Zarshouran and Sari Gunay Mines. The Agh Darreh, Muteh, and Sari Gunay Mines had probable reserves of 30 t, 14 t, and 63 t, respectively (Ghorbani, 2013, p. 322). Ore reserves in Zarshouran were estimated at 11.5 Mt with an average grade of 7.9 grams per metric ton (g/t) gold, equivalent to 91 t of gold, which would make the mine the largest in Iran once it becomes fully operational. Pilot gold production began at the Zarshouran Mine in September 2014. In November 2014, the Zarshouran refinery began operating with a production

capacity of 3 t/yr of gold, 1 t/yr of mercury, and 2.5 t/yr of silver (Mines & Mining Industries English Magazine, 2015; Mukhopadhyay, 2015). Gold extraction was expected to start in Sari Gunay in 2015 with a metal output target of 2 t/yr by 2016; average grade of reserves was about 1.6 g/t gold (Press TV, 2015f). The completion of the mine by Zar Kuh Mining Co. had been delayed in September 2013 and then again in October 2014, but production could eventually exceed 3 t/yr of gold (Minews, 2015c).

## Iron and Steel

*Iron Ore.*—Iran was the leading iron ore and direct-reduced iron (DRI) producer in the MENA region (World Steel Association, 2015, p. 97, 102; Reichl and others, 2016, p. 135; U.S. Geological Survey, 2016, p. 91; Mowafa Taib, U.S. Geological Survey, unpub. data, 2016). In 2014, the country's production of iron ore concentrate remained at 48.5 Mt, of which 21 Mt was pelletized iron ore (Karbasiyan, 2014, p. 4; World Steel Association, 2015, p. 102). DRI output remained at 14.6 Mt, whereas pig iron output increased by 39 percent to 2.8 Mt (World Steel Association, 2015, p. 91, 97). Iran's iron ore production has nearly tripled over the past 10 years and continues to grow at an annual rate of 10 percent; if sustained, the rate of growth would be sufficient to meet the Government's 2025 target output of 66.2 Mt of iron ore (table 2; fig. 3 Karbasiyan, 2014, p. 4). In 2014, Iran exported 21.8 Mt of iron ore, making it the ninth-leading exporter globally (World Steel Association, 2015, p. 103). Exports were projected to decrease to less than 10 Mt by 2017 owing to increased consumption of iron ore by domestic steel producers and declining global prices (Serapio, 2015). Most of Iran's iron ore exports were received by China. In 2015, exports to China decreased by 40 percent from 2014 to 13.2 Mt owing primarily to prevailing low global iron ore prices (Financial Tribune, 2016a).

There were 156 iron ore mines in operation in 2014; however, 8 mines accounted for about 86 percent of Iran's total reserves. The Sangan, Gol-e-Gohar, and Chadormalu Mines, in which IMIDRO owned minority shares, were the largest iron ore mines operating in the MENA region with reserves of 1.2 Gt, 1.0 Gt, and 0.2 Gt, respectively (table 1; Karbasiyan, 2014, p. 9). In March 2015, IMIDRO announced the discovery of 200 Mt in new iron ore reserves at the Sangan Mine (Mining.com, 2015). The leading producers of iron ore were Chadormalu Mining & Industrial Co., Gol-e-Gohar Iron Ore Co., and Iran Central Iron Ore Co. (table 1; Iranian Mines and Mining Industries Development and Renovation Organization, 2012; Press TV, 2015e). Privately owned iron ore mines had a total capacity of 12 Mt/yr. As almost all of their output was exported, they accounted for about 20 percent of domestic production, but nearly half of Iran's iron ore exports in 2014 (Angel, 2015). Approximately 70 percent of private capacity went offline from late 2014, when about 6 Mt of capacity had shut

down, to early 2016 owing to low prevailing global iron ore prices, lack of export competitiveness caused by operational costs, and increase in mining royalty enacted in March 2015 (Financial Tribune, 2014, 2016a; Thomson Reuters, 2015).

Iran's production of iron ore pellets and DRI was projected to increase with the construction of multiple new iron facilities. In addition, the Gol-e Gohar and Sangan Mines planned to initiate pellet production in March 2016, increasing capacity by more than 5 Mt/yr, which would reduce the country's reliance on imports. In February 2016, Danieli Group of Italy and IMIDRO launched the Persian Metallics project with an output target of 6 Mt/yr of pellets for steelmaking using electric arc furnace (EAF) technology in southern Iran (Moggridge, 2016a; Press TV, 2016a). Also as of February 2016, KIOCL Ltd. of India planned to build an iron ore pellet complex with a capacity of 1.1 Mt/yr and Hormozgan Steel Co. planned to nearly double the capacity of its DRI plant in Bandar 'Abbās, Hormozgān Province, to 3 Mt/yr (table 1; Das and Serapio, 2016; Havasi, 2016).

*Steel.*—Iran was the second-leading steelmaker in the MENA region after Turkey (World Steel Association, 2015, p. 1–2; Mowafa Taib, U.S. Geological Survey, unpub. data, 2016); however, one-half of its downstream industry either produced below capacity or remained nonoperational in early 2016 (Frost & Sullivan, 2016). In 2014, the country's production of crude steel increased by 6 percent to 16.3 Mt (World Steel Association, 2015, p. 2, 2016). About 83 percent of steel production was based on electric arc furnace (EAF) technology (World Steel Association, 2015, p. 18). To reach the Government's 2025 target output of 52 Mt of crude steel, an average annual growth rate of 11 percent would be required starting in 2015 compared with 7 percent registered in the previous decade (table 2, fig. 3; Iranian Mines and Mining Investment Development and Renovation Organization, 2015a, p. 13). It would also require Iran to boost its production capacity of iron ore concentrate to 53.5 Mt from the current 44 Mt; sponge iron, to 58 Mt from 26 Mt; and pellets, to 88 Mt from 28 Mt (World Steel Association 2015, p. 54, 60, 65, 70). In 2014, Iran exported 1.54 Mt of steel products including ingots and flat, long, semifinished and finished products (World Steel Association, 2015, p. 54, 60, 65, 70). The country's steel exports were expected to reach 7 Mt at the maximum in 2025 (Havasi, 2016).

Iran's leading steel-producing companies were Mobarakeh Steel Co., Khuzestan Steel Co., and Esfahan Steel Co, with market shares of 47 percent, 23 percent, and 20 percent, respectively (table 1; Tasnim News Agency, 2015). Esfahan Steel Co., the sole user of blast furnace technology in Iran, had a total capacity of 3.6 Mt/yr (Yazdizadeh, 2016). IMIDRO planned four major plant construction projects in order to increase the sector's production capacity, including multiple steel plants in Bandar 'Abbās (Moggridge, 2016b) and the Arvand free trade zone (FTZ) (Financial Tribune, 2015c), with total crude steel capacities of 2.4 Mt/yr and 5 Mt/yr, respectively, and plants in Chābahār (Jin, 2016) and the Island of Qeshm (Karbasian, 2015, p. 5), with capacities

of 1.6 Mt/yr each (Karbasian, 2015, p. 5; Mehr News Agency, 2015). The joint construction of three new steel plants along Iran's southern coast by Kish South Kaveh Steel Co. (SKS), Arvand Jahanara Steel Co., and Kuwait's United Steel Industrial Co. was planned in order to turn the Arvand FTZ into Iran's steel production and export hub with its own powerplants for energy self-sufficiency (table 1; Bozorgmehr, 2015; Financial Tribune, 2015c).

Three new steelmaking projects were launched in Iran in 2016. In February, SKS launched the second phase of its project to double total production capacity of three steel plants in Bandar 'Abbās to 2.4 Mt/yr (Moggridge, 2016b). The company expected to complete the expansion in March 2017 (Mostafazan Foundation, 2016), at which point it would account for about 10 percent of Iran's annual steel production. Also in February 2016, POSCO of Republic of Korea signed an agreement with Pars Kohan Diarparsian Steel (PKP) to begin the joint construction of a 1.6-Mt/yr steel plant in Chābahār in 2017 and to add facilities for the production of cold-rolled and galvanized steel in 2019. In April 2016, Danieli signed an agreement with Butia Iranian Steel Co. (BISCO) to jointly construct a 1.5-Mt/yr steel plant (table 1; Jin, 2016; Karimov, 2016; Moggridge, 2016b; Mostafazan Foundation, 2016).

## Lead and Zinc

Iran was the second-leading producer of lead and zinc in the MENA region after Turkey, although it was a minor producer globally (Reichl and others, 2016, p. 146, 150; Mowafa Taib, U.S. Geological Survey, unpub. data, 2016). In 2014, the country produced 700,000 t of zinc and lead concentrates as well as 142,000 t and 72,000 t of zinc and lead ingots, respectively. To reach the Government's 2025 target output of 300,000 t of zinc, an average annual growth rate of 7 percent would be required starting in 2015, more than double the 3 percent registered in the previous decade (table 2, fig. 3; Iranian Mines and Mining Investment Development and Renovation Organization, 2015a, p. 13). Processors used only 35 to 40 percent of their 2-Mt/yr total capacity owing to insufficient ore production at mines. The total refining capacity of 60 active processing units in the country was 450,000 t/yr of zinc ingots and 420,000 t/yr of lead ingots. Iran exported more than half of its zinc and lead ingot output. In 2014, exports amounted to 80,900 t of zinc ingots and 60,400 t of lead ingots, whereas imports were only 630 t and 500 t, respectively (Ministry of Industry, Mine, and Trade, 2014, p. 32, 34; Iranian Mines and Mining Industries Development and Renovation Organization, 2015b; Minews, 2015d).

Iran's two largest zinc mines were Mehdiabad with reserves of 160 Mt of ore grading at 2 percent zinc and Angouran, with reserves of 9 Mt of ore grading at 26 percent zinc and 6 percent lead (Iranian Mines and Mining Industries Development and Renovation Organization, 2015b; Minews, 2015f). The Mehdiabad Mine was planned to become Iran's main supplier to the domestic industry upon the extraction of

all zinc deposits in Angouran. The capacity of the Angouran Mine was increased from 0.7 Mt/yr to 1 Mt/yr (Minews, 2015b) in 2014 by Calcimin Co. In 2015, a total of 750,000 t of zinc and lead ore was projected to be extracted at the mine through both open pit and underground mining; at that rate, its reserves would be exhausted by 2027 (Iran Minerals Production and Supply Co., 2015a; Minews, 2015a). Angouran's ore was processed by 78 zinc and lead plants located in the vicinity of the mine in Zanjān Province, most of which were relatively small. The three largest processors were Calcimin Co. with 500,000 t/yr of zinc and 30,000 t/yr of lead capacity, Zangan Zinc Industry LLP with 250,000 t/yr of zinc capacity, and Zanjān Zinc Kholes Sazan Industries Co.'s 200,000 t/yr of zinc and 20,000 t/yr of lead capacity (Iran Zinc Mines Development Co., undated, p. 2, 15; Zanjān Zinc Kholes Sazan Industrial Group, 2016). In March 2015, operations resumed at the Mehdiabad Mine after a \$1 billion investment by Mehdiabad Zinc Co., a subsidiary of Karoun Dez Dasht (K.D.D.) Group, which had a 25-year extraction license to the site (Minews, 2015d). The mine's processing unit had a current capacity of 100,000 t/yr of zinc concentrate, which was planned to be increased to at least 800,000 t/yr (Minews, 2015d; Iranian Mines and Mining Industries Development and Renovation Organization, 2016). Mehdiabad Zinc continued waste stripping operations in the Mehdiabad Mine. The company planned to strip 180 Mt of waste from the mine, whereas only 10 Mt had been stripped in the previous six decades (Minews, 2015d). The company Mehdiabad Zinc also planned to build a processing unit near the mine with a capacity of 100,000 t/yr of zinc and lead ingots by 2018 (table 1; Financial Tribune, 2015b, e; Karbasian, 2015; Minews, 2015a, d; Mobin Mining and Construction Co., 2016b).

## Rare-Earth Elements

Iran produced rare-earth elements on an experimental scale. In February 2016, the National Research Center for Minerals located in Alborz Province produced samples containing cerium oxide, lanthanum oxide, mischmetal (a combination of light rare-earth elements), neodymium oxide, praseodymium oxide, and yttrium oxide. In April 2016, plans were announced to begin extracting rare-earth elements as byproducts of uranium mining. IMIDRO began exploration for rare-earth elements and the identification of potential targets in 2014 in order to attract foreign investment and technology for rare-earths processing in Iran. Identified deposits with rare-earth mineralization include (1) low-thorium hydrothermal monazite associated with iron oxide-apatite deposits in the Bāfq mining district of central Iran, (2) monazite associated with a heavy-mineral placer deposit in Marvast, southern Yazd Province, and (3) apatite in the Esfordi, Gazestan, Lakeh-Siah, and Zarigan deposits of the Posht-e-Badam Block in central Iran (Ghorbani, 2013; Scientific Quarterly Journal, 2013; Iran International Magazine, 2015; Mehr News Agency, 2016; Tasnim News Agency, 2016b).

## Outlook

Iran's nonfuel mineral output is expected to increase in the post-sanctions era as new deposits are identified or developed across the country and facility capacities are expanded with a view towards diversification of the economy away from hydrocarbons. In particular, the production of aluminum, alumina, bauxite, copper, gold, iron ore, lead, steel, and zinc may increase as a result of the identification of mineral deposits in previously unexplored areas, construction and (or) expansion of mineral extraction and processing complexes, and upgrading of existing mines and facilities as planned by the Government. Research is being officially funded for the development other nonfuel mineral resources, such as rare-earth elements contained in iron-oxide-phosphate deposits (Mehr News Agency, 2016). Recovery of byproduct minerals contained in copper ore, such as molybdenum and other metals, may add value to existing mining operations. The lifting of international sanctions on Iran is expected to result in higher inflows of foreign direct investment into the country's mineral sector. As of June 2016, IMIDRO was in talks with Australia's Rio Tinto Group, Switzerland's Glencore plc, Netherland's Trafigura Beheer BV, and Germany's Aurubis AG on the development of new aluminum, copper, gold, and steel projects in Iran (Els, 2016; Press TV, 2016b) and NICICO sought foreign investment in 16 copper production capacity expansion projects (National Iranian Copper Industries Co, 2016b). Whether annual mineral commodity production increases as rapidly as envisioned by the Government will depend largely on integration of modern technology into facilities; provision of energy to aluminum, copper, and steel plants at competitive prices to international investors; stabilization of, or increase in, global metal prices for aluminum, copper, and zinc; and growth of exports in the face of competition for foreign markets by other major mineral producers, such as Turkey and the Persian Gulf countries. Iran's predominantly young, educated workforce may contribute to the country's minerals industry through labor force, technology, and demand factors (Mottahedi and Mottahedi, 2012; Iran International Magazine, 2015).

## Acknowledgments

The authors would like to gratefully acknowledge the many valuable suggestions of Mowafa Taib, Thomas Yager, Nedal Nassar, Daniel Edelstein, John DeYoung, Steve Textoris, and Steve Fortier, who helped make this Circular a much better publication, and thank Mr. Taib, Mr. Textoris, and Mr. Fortier for their constant support throughout the preparation of its manuscript and figures.

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Manuscript approved June 24, 2016

Prepared by the USGS Science Publishing Network  
Reston Publishing Service Center

Edited by Natalie Juda

Illustrations and layout by Caryl J. Wipperfurth

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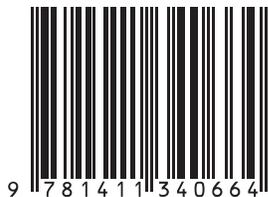
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I S B N 978-1-4113-4066-4



9 781411 340664

ISSN 1067-084X (print)  
ISSN 2330-5703 (online)  
<http://dx.doi.org/10.3133/cir1421>