Iron ore is the source of primary iron for the world’s iron and steel industries. Its production can be reported as crude ore, usable ore or iron content of ore. Historically, the U.S. Geological Survey (USGS) used reported crude ore production from China in tabulations of world iron ore production while other countries have typically reported their production in terms of usable iron ore. When China’s crude ore production was tabulated with usable ore production from other countries, world iron ore production totals have been overestimated by 10 percent to a high of 32 percent (Figs. 1, 2). The significant increase in iron ore production in China from 2000 through 2015 amplified the overestimation resulting from tabulating inconsistent forms of the material. Sources of data for usable iron ore production in China, beginning in 2000, have become available. This article documents the revision of world iron ore production totals and augments historical China iron ore production figures to show both crude and usable ore values.

**Terminology**

- Crude ore refers to ore extracted from the ground that has not been processed or concentrated (beneficiated) to increase its iron content. The iron content of mined iron ore can range from less than 10 percent in low-grade deposits to more than 60 percent in high-grade deposits.
- Usable ore (or finished ore) refers to ore that can be used directly in a downstream process. Usable iron ore typically contains from 58 percent to 65 percent iron (Fe) content and may include products such as concentrates, direct-shipping ore, pellets, and sinter.
- Iron content, also referred to as metal content or grade, denotes the amount of elemental iron in the crude or usable ore.

**Background**

Iron ores consumed in the steel industry typically require an iron content greater than 58 percent before being considered commercially usable. Iron ores that are not commercially usable must undergo beneficiation to raise the iron content. Approximately 98 percent of the world’s usable iron ore production is consumed in blast furnaces to make pig iron, which is further processed to make steel.

High-grade iron ore mines can supply usable iron ore, known as direct-shipping ore, to blast furnaces, with minimal physical processing and no beneficiation. With direct-shipping ore, the reported production for crude ore and usable ore are the same. Ore from low-grade deposits must undergo beneficiation to increase the iron content before it can be used by the steel industry. In this instance, the mined material is called crude ore and post-beneficiation concentrates are called usable ore; the amount produced will be less than the crude ore amount. With the notable exceptions of countries such as Australia and Brazil, most of the world’s iron ore deposits are low-grade and require beneficiation.

**Differences in iron ore reporting**

**Crude ore.** Crude ore is not reported by most countries as it is an intermediate product, although some countries use crude ore for tax calculations. In China, iron ore typically ranges from 10 percent to 35 percent Fe. Among member companies of the China Iron and Steel Association (CISA), predominantly large-scale producers, the average grade of crude ore was 28.8 percent in 2014 and members accounted for 21 percent of China’s iron ore production in 2013 (China Steel Yearbook Editorial Board, 2015). Among non-CISA members, believed to be mostly small and state-sponsored iron ore mines, the iron content of crude ore can vary greatly from year to year. Relatively small mines may begin operation when demand is high and (or) the price of iron ore increases. Certain mines may be state sponsored and their rate of production is at the discretion of the government, as opposed to market conditions. Consequently, China’s reported crude ore
production was used because an average reserve grade or assumed mill-head grade was not available to estimate usable ore for most years.

**Usable ore.** Usable ore for making pig iron and steel typically ranges from 58 percent to 65 percent Fe. Because of this narrow range of iron content, usable ore provides a more uniform basis for comparison and tabulation of global iron ore production.

For countries with deposits that are considered high-grade, such as Australia and Brazil, usable iron ore production consists primarily of direct-shipping ore. Direct-shipping ore may be crushed for ease of transportation, but not chemically modified before sale. The iron content for these products typically ranges from 58 percent to 60 percent. In countries with mid- and low-grade deposits, the crude ore is beneficiated to produce iron concentrates with ideal iron contents greater than 60 percent (Association for Iron and Steel Technology, 1999). The concentrates may be further processed with binders to create iron ore pellets, which provide a chemical and thermal benefit in blast furnace smelting. There are several variations of these products, such as fines, flux pellets and sinter. However, all are considered usable ore.

The CISA reports usable ore production for China in the *China Steel Yearbook* in addition to crude ore production sourced from the National Bureau of Statistics of China, the same source cited by the USGS for crude iron ore production for China. Even though their members represent only a portion of China’s production, the data purport to cover China’s total production of usable ore. In 2013, CISA reported that the average grade of iron ore concentrates was 61.8 percent Fe. CISA also reported that concentrates accounted for 98 percent of the total usable ore produced in China for that year (China Steel Yearbook Editorial Board, 2015). Using CISA data for China’s usable iron ore production, the USGS has revised its iron ore data series back through 2000. As shown in Figs.1 and 2 and Table 1, iron ore production for China and world production totals decrease dramatically using usable ore production instead of crude ore production.

**Iron content.** Iron content might be considered a preferable method of tabulating global production. However, the iron content of usable iron ore production is seldom reported except as a general ratio for annual production. The variations in iron ore deposits and mining plans can result in fluctuations in iron grades for crude ore and for usable ore produced throughout the year at an operation. Iron ore is typically sold in quantities of hundred thousand tons with only an average chemical composition obtained from sampling of the ore. For this reason, using the average iron content for an entire operation or country may not be available or representative of the actual production.

In calculating the annual iron content of China’s iron ore production, the USGS previously used the iron content of the reported reserves, which was reported as 31 percent in 2000. Extrapolating crude ore production reported by the National Bureau of Statistics of China and usable ore production reported by CISA across the 15-year period, the USGS calculated that the grade of China’s crude ore trended downward from 31 percent Fe in 2000 to 18 percent Fe in 2013.

**USGS reporting of global production**

Owing to increased steel demand in China, small-scale miners with lower-grade deposits were brought into production to meet domestic iron ore demand.
Iron Ore

demand. As the production share of large-scale and established miners decreased, average ore grades decreased. Ore grades at the large-scale mines were higher, which, along with economies of scale, made their operations economic. The share of crude ore production from China’s Iron and Steel Association members decreased, from 47 percent in 2000 to 21 percent in 2013.

In tabulations of world production, the USGS previously reported the National Bureau of Statistics China’s data for iron ore production in China and footnoted the data as being crude ore production. China reached unprecedented levels of iron ore production and consumption for the country, driven by steel production, as the economy of China grew at unprecedented rates during the first decade of the new millennium (Morrison, 2014). China’s share of global production of pig iron and raw steel grew from 23 percent and 15 percent in 2000 to 60 percent and 50 percent of the world’s production in 2014, respectively (World Steel Association, 2016; 2001).

In recent years, China relied on imports from major iron ore producing countries, such as Australia and Brazil, in addition to domestic iron ore production to supply the raw materials for steel production. Imports of iron ore into China increased from 69.9 Mt (77 million st) in 2000 to 953 Mt (1.05 billion st) in 2015. Exports from Australia and Brazil increased from 157 Mt (173 million st) and 160 Mt (176 million st) in 2000 to 810 Mt (892 million st) and 366 Mt (402 million st) in 2015 (World Steel Association, 2016; 2001). Of imports into China in 2015, Australia and Brazil accounted for approximately 64 percent and 20 percent, respectively (United Nations Commodity Trade Statistics Database, undated). Iron ore was a critical material for the rapid rate of urbanization within China (United Nations, 2014).

Based on revised USGS data, from 2000 to 2002, China produced an average of 12 percent of global usable iron ore. Beginning in 2003, the previously stable level of China’s production began to increase (Table 2). From 2002 to 2013, China increased usable ore production from 115 Mt to 417 Mt (127 million to 460 million st). By comparison, the crude ore production in China increased from 233 Mt (256 million st) in 2002 to 1.45 Gt (1.6 billion st) in 2013. The percentage increase in production during the time period from 2002 to 2013 was 263 percent for usable ore and 522 percent for crude ore. The large differences in the percentages reflect the falling grade of crude ore produced during this period.

The increasing discrepancy resulting from the different reporting basis on world totals is apparent in Tables 1 and 2. As Chinese crude ore production increased, the world production totals became increasingly overestimated. The percent difference in world totals calculated with China on a crude ore basis compared with a usable ore basis was 11 percent in 2002 and 32 percent in 2013.

When reporting world production tabulated with China’s usable ore, China’s share of global iron ore production rose from 12 percent in 2000 to an estimated 16 percent in 2015. In previously reported world production totals using China’s crude ore production, China’s share of global iron ore production rose from 21 percent in 2000 to an estimated 42 percent in 2015. Based on usable ore, China’s share of the global increase in iron ore production from 2000 to 2014 was only 6 percent compared with 30 percent when calculated using crude ore.

Similarly, the share of world production for iron ore-producing countries is affected by the differences in reporting standards. When reporting China on a usable-ore basis, Australia was the world’s leading producer in 2013 with 31 percent

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**Table 1**

Revised China and world production of crude ore, usable iron ore, and iron content. [Million metric tons].

<table>
<thead>
<tr>
<th>Year</th>
<th>China Crude Ore</th>
<th>World Total</th>
<th>China Usable Ore</th>
<th>World Total</th>
<th>China Iron ore content</th>
<th>World Total</th>
</tr>
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<tbody>
<tr>
<td>2000</td>
<td>223</td>
<td>1,080</td>
<td>112</td>
<td>969</td>
<td>69</td>
<td>610</td>
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<td>2001</td>
<td>211</td>
<td>1,040</td>
<td>108</td>
<td>937</td>
<td>67</td>
<td>591</td>
</tr>
<tr>
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<td>1,100</td>
<td>115</td>
<td>982</td>
<td>71</td>
<td>621</td>
</tr>
<tr>
<td>2003</td>
<td>263</td>
<td>1,210</td>
<td>127</td>
<td>1,080</td>
<td>79</td>
<td>679</td>
</tr>
<tr>
<td>2004</td>
<td>320</td>
<td>1,360</td>
<td>156</td>
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<td>97</td>
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<tr>
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<td>420</td>
<td>1,550</td>
<td>186</td>
<td>1,320</td>
<td>115</td>
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<td>597</td>
<td>1,830</td>
<td>237</td>
<td>1,470</td>
<td>147</td>
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<td>707</td>
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<td>1,680</td>
<td>214</td>
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<td>780</td>
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<td>399</td>
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<td>1,710</td>
<td>232</td>
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<tr>
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<td>2,930</td>
<td>442</td>
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<td>420</td>
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<td>261</td>
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<tr>
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<td>3,280</td>
<td>417</td>
<td>2,230</td>
<td>259</td>
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<td>3,290</td>
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<td>232</td>
<td>1,400</td>
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</table>

1 Data are rounded to no more than three significant digits; may not add to totals shown.
2 Iron ore content is calculated as 62% percent of usable ore.
3 Data reported by the National Bureau of Statistics of China.
4 Estimated; reported figures were not available at the time of publication.
of world production, whereas China and Brazil constituted 19 percent and 17 percent, respectively. When reporting China on a crude ore basis, China was the world's leading producer in 2013 with a 44 percent share of world production; Australia and Brazil's shares were reduced to 21 percent and 12 percent, respectively.

**Conclusion**

The USGS is revising its iron ore production data for China from the year 2000 forward by including usable ore in addition to crude ore and calculating the world total based on China usable ore production. Prior to 2000, data for usable iron ore for China are unavailable, and the data series will still be reported and footnoted as crude ore. Additionally, iron contents based on usable ore have been revised from the year 2000 forward. If iron content for China is reported in future CISA or other publications, the USGS will use that figure for its calculations of specific annual production totals.

Beginning with the iron ore chapter of the 2014 USGS Minerals Yearbook, Volume I, Metals and Minerals, and the iron ore chapter of the Mineral Commodity Summaries 2017, world iron ore production totals will be tabulated using China usable ore and estimated iron-content basis for all countries available at https://doi.org/10.5066/F7D21VRM

**References**


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