

World Mineral Production



2002–2006



British
Geological Survey

NATURAL ENVIRONMENT RESEARCH COUNCIL

BRITISH GEOLOGICAL SURVEY

WORLD MINERAL PRODUCTION
2002–06

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PREFACE

This volume is the fourth in the series *World Mineral Production*, published by the British Geological Survey. The series that preceded it, *World Mineral Statistics* and *Statistical Summary of the Minerals Industry*, recorded data from 1913.

This publication is compiled from a more comprehensive database, maintained by the British Geological Survey, that can provide special reports tailored to users' needs. Examples of regional reports, such as *European Mineral Statistics*, *African Mineral Production* and *China and South East Asia Production*, are available for free download on the mineralsUK website (www.mineralsUK.com). Commodity reports, including production, exports and imports, can also be prepared to order. The database holds trade statistics for 32 European countries and other major trading countries.

In this volume, for the first time, we have included reviews on selected minerals and metals. These provide information on uses, prices, recent production trends and industry events in 2007.

China continues to dominate news in the minerals sector as its output and consumption of mineral commodities increases. In terms of mine production in 2006, China was the largest producer of almost half of the commodities covered in this book. It became the top producer of refined copper for the first time, almost doubling output in five years. Chinese production of iron ore increased by 250 per cent over five years and comprised a third of world production in 2006, while coal production reached 38 per cent of global production.

The British Geological Survey aims to provide a reliable, comprehensive and continuous set of data covering most of the minerals that enter international trade. In each successive volume account is taken of revisions and information received after the publication of the previous issue, thus data for every year are as up-to-date as is practicable. The objective remains to present the latest complete production information obtained from official bodies in individual countries, although other sources are also used to ensure completeness and accuracy. The cooperation afforded to the British Geological Survey by numerous national and international organisations is gratefully acknowledged.

I would welcome any criticisms and suggestions that might help us to meet your changing needs, particularly with respect to the coverage of statistics and the format in which they are made available.

John N Ludden
Executive Director

British Geological Survey
Keyworth
Nottingham

February 2008

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EXPLANATORY NOTES

Coverage

World Mineral Production covers the majority of economically important mineral commodities. For each commodity constant efforts are made to ensure that as many producing countries as possible are reported. For some commodities, where statistics on production are not publicly available, estimates are made. Users of this compilation are advised that more statistical information than can be included in a publication of this nature is held in the British Geological Survey files and is available for consultation. Historical data (1913-1970) can be obtained from the predecessors to this series entitled *World Mineral Statistics* and the *Statistical Summary of the Mineral Industry*.

Arrangement of countries

Countries are ordered alphabetically in geographical groupings as follows:

- Europe
- Africa
- North and Central America, including the Caribbean
- South America
- Asia
- Australasia, including the Pacific Islands

So far as possible the nomenclature follows the London Diplomatic List.

Metals

Mine production of many metals is expressed in terms of metal content. This is clearly indicated at the head of the table, adjacent to the unit used. For aluminium, cobalt, copper, iron, lead, nickel, tin and zinc, mine production and metal production are shown in separate tables. Unless otherwise specified, metal production statistics relate to metal recovered from both domestic and imported materials, whether primary or secondary, but exclude remelted material.

World totals

For certain minerals and metals no world total is shown due to the non-availability of certain individual country totals.

Exclusion of Warranty

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Acknowledgements

Compilation of this volume of mineral statistics has been possible only by obtaining information from a very large number of organisations throughout the world, chiefly home and overseas government departments and specialist national or international authorities concerned with particular sectors of the minerals or metals industries. To all these bodies the British Geological Survey expresses its grateful acknowledgement for the information made available, whether in published form or provided by direct correspondence.

Particular acknowledgement is made to the Mines Departments and other government agencies of many countries whose regular statements, yearbooks and other reports are worthy of direct consultations by readers in search of detail.

Specialist commodity organisations which have kindly allowed information to be reproduced include the International Copper Study Group, the International Lead and Zinc Study Group, the International Nickel Study Group and the International Fertilizer Industry Association Ltd. In a few instances, information on specific commodities has been obtained directly from company sources. The co-operation of other members of the International Consultative Group on Non-Ferrous Metal Statistics is also gratefully acknowledged.

Supplementary information is also obtained from publications dealing with a wider range of commodities such as Société de l'Industrie Minière, *Annuaire Statistique Mondial des Minerais et Métaux*; World Bureau of Metal Statistics, *World Metal Statistics* and, *Metallstatistik*; publications of the Interstate Statistical Committee of the CIS, the United States Geological Survey, and UN agencies.

In addition, information has been obtained from the websites of the following organisations, companies, statistical offices and government departments: United Nations; Kaolin & Plastic Clays Europe; International Iron and Steel Institute; Kimberley Process; Eurofer; World Nuclear Association; Organisation of the Petroleum Exporting Countries; Eurostat; European Aggregates Association; South East Asia Iron and Steel Institute; Instituto Latinoamericano del Fierro y el Acero; RNC Gold; Glencairn Gold; Glamis Gold; Break Water Resources; Falconbridge Ltd; Inmet Mining; Stillwater Mining; Aluminium de Grece; New Boliden; Eurozinc Mining Corporation; Qatar Steel Company; Northern Territory Government, Australia; Department of Primary Industries Victoria, Australia; Mineral Resources Tasmania, Australia; Australian Bureau of Agricultural & Resource Economics; Vereinigung der Osterreichischen Zementindustrie, Austria; Federation de l'Industrie Cimentiere Belge, Belgium; Statistics Belgium; Instituto Nacional de Estadística Bolivia; Departamento Nacional De Producao Mineral, Brazil; Grupo Paranapanema, Brazil; Agencia Nacional do Petroleo, Brazil; Natural Resources Canada; Statistics Canada; Canadian Association of Petroleum Producers; Mineral Resources of Quebec, Canada; China Mining Association; Czech Republic Statistical Office; Statistics Denmark; Banco Central de la Republica Dominicana, Dominican Republic, Banco Central del Ecuador; Geological Survey of Finland; New Boliden, Finland; Federation des Minerais, Mineraux Industrielles et Metaux non Ferreux, France; Comite Professionel de Petrole, France; Ministere de l'Economie, des Finances et de l'Industrie, France; Infociments, France; Statistisches Bundesamt Deutschland, Germany; National Statistical Service of Greece; Federacciai, Italy; Unione Petrolifera, Italy; Istituto Nazionale di Statistica, Italy; Salt Industry Centre, Japan; Korea Institute of Geoscience and Mineral Resources, Republic of Korea; Statec, Luxembourg; Bank Negara Malaysia; Pemex, Mexico; Statistics Office of Montenegro; Secteria de Economia, Mexico; Servicio Geologico de Mexico; Centraal Bureau voor de Statistiek, Netherlands; Staatstoezicht op de Mijnen, Netherlands; Ministry of Economic Development, New Zealand; Central Bank, Nicaragua; Statistisk Sentralbyra, Norway; Ministry of National Economy, Oman; Chamber of Mines and Petroleum, Papua New Guinea; PeruPetro; Ministerio de Energia y Minas, Peru; Sociedad Nacional de Minería Petroleo y Energía, Peru; Mines and Geosciences Bureau, Philippines; Instituto Nacional de Estadística, Portugal; Unesid, Spain; Staatsolie Maatschappij, Suriname; Sveriges Geologiska Undersokning, Sweden; Jernkontoret, Sweden; Statistiska Centralbyran, Sweden; Bank of Thailand; Central Bank of Trinidad and Tobago; Department of Trade and Industry, United Kingdom; Energy Information Administration, United States of America; Direccion Nacional de

Minería y Geología, Uruguay; General Statistics Office, Vietnam; Central Statistical Organisation, Republic of Yemen.

Units

The Statistics shown in this volume are expressed in metric units. The following factors are given for converting to non-metric units:

tonnes \times 0.9842 = long tons
 tonnes \times 1.1023 = short tons
 kilograms \times 2.2046 = pounds
 kilograms \times 32.1507 = troy ounces
 cubic metres \times 35.3147 = cubic feet
 1 tonne of crude petroleum equals on average 7 barrels of crude petroleum.
 1 flask mercury = 34.5 kilograms
 1 metric ton unit = 10 kilograms

Symbols

...	figures not available
0	quantity less than half unit shown
—	nil
*	estimated
BGS	British Geological Survey
c.i.f	Cost, Insurance, and Freight. The seller's price includes the cost of the goods, the insurance of the goods to their destination port, and the cost of freight.
f.o.b.	Free On Board. The seller is responsible for the costs of delivering goods to the ship. The buyer is responsible for transportation and insurance costs from that point.
TWh	Terawatt hours (1 TWh = 1 thousand million kilowatt hours)

STATISTICAL TABLES

BAUXITE – ALUMINA – ALUMINIUM

Characteristics

Bauxite, the most common ore of aluminium, is a hard, reddish, clay-like material. It was first discovered near the village of Les Baux in southern France. Bauxite occurs in three main forms: gibbsite (aluminium hydroxide), böhmite and diasporite (both aluminium-oxide-hydroxides). Gibbsite is the dominant form mined. Bauxite is a residual type of ore deposit that has been left on the land surface following intense weathering and the removal by leaching of other minerals. Consequently, it tends to occur mainly in tropical and sub-tropical regions such as the Caribbean, parts of Africa, South America, and Australia. The largest reserves of bauxite are in Guinea (7400 million tonnes), Australia (5800 million tonnes) and Jamaica (2000 million tonnes); (Bray, 2008).

Alumina (aluminium oxide) is a white granular material produced from bauxite by the Bayer refining process, which involves dissolving the bauxite in caustic soda at high temperature and pressure. Aluminium hydroxide is then precipitated from the liquid and this is calcined to form aluminium oxide powder.

Aluminium metal is produced by the electrolysis of alumina dissolved in a molten salt in a smelter. This process is a very large consumer of electrical power and as a consequence the availability of cheap electricity tends to determine the location of aluminium smelters.

Pure aluminium is a silver-white metal with many desirable characteristics. It is light, non-toxic, non-magnetic and non-sparking. It is easily formed, machined or cast, and forms alloys with many other metals such as copper, magnesium, and silicon. Aluminium and most of its alloys are highly resistant to corrosion. It is also a very good conductor of electricity (IAI, 2007).

Uses

Bauxite is primarily used to produce alumina through the Bayer process. However, between 5 and 15 per cent of bauxite is of non-metallurgical grade and most of this is calcined into 'brown fused alumina' for use in the abrasive or refractory markets.

Approximately 90 per cent of alumina produced in the world is used in the production of aluminium metal through smelting. Some of the remaining 10 per cent is calcined at higher temperatures than smelter grade alumina and is used for a wide range of refractory and ceramic purposes. Fused alumina is formed in electric arc furnaces at high temperatures and is used in the manufacture of abrasives and refractories (Tran, 2007a).

Aluminium is, in terms of tonnage, the most widely used non-ferrous metal. It is used extensively in the transport manufacturing industry (most importantly in the aerospace industry but also in road vehicles, trains and ships), packaging (cans, foil), water treatment, construction (windows, doors, wire), cooking utensils, electrical transmission lines, electronics, CDs and transistors. It is also used in paints and rocket fuel. In most uses it is alloyed with small amounts of other metals such as magnesium and manganese. Recycling is an important feature of aluminium use and recycled metal (including manufacturing scrap) contributes about 39 per cent of consumption.

World production in 2006

Australia mined the most bauxite in 2006, extracting 32 per cent of the world total. Production here has increased by 14 per cent since 2002. The second largest is Brazil, with 12 per cent, closely followed by China, with an estimated 11 per cent. China's bauxite production has risen by 62 per cent since 2002 (although it remains heavily dependent on bauxite imports), whereas Brazil's production has risen by 74 per cent over the same period.

The fourth largest producer of bauxite in the world is Guinea. Here production fell in 2006 compared to 2005, and the increase from 2002 to 2005 was only 10 per cent resulting in volumes falling below those of Brazil and China. The other country showing a significant rise is India, where production has increased by 54 per cent since 2002. In 2006 India's output overtook that of Jamaica, which had been a major producer of bauxite for many years.

Australia is also the world's largest producer of alumina, with 25 per cent of the world total. China is the second largest producer, with 19 per cent. Other major producers are Brazil, with nine per cent of the world's total; the USA, with seven per cent; and Jamaica, with six per cent. Production in China has increased by more than 150 per cent since 2002 and Brazil's output has increased by 74 per cent over the same period. Romania and Azerbaijan have also shown significant increases since 2002, although each had only one per cent of the world production total in 2006.

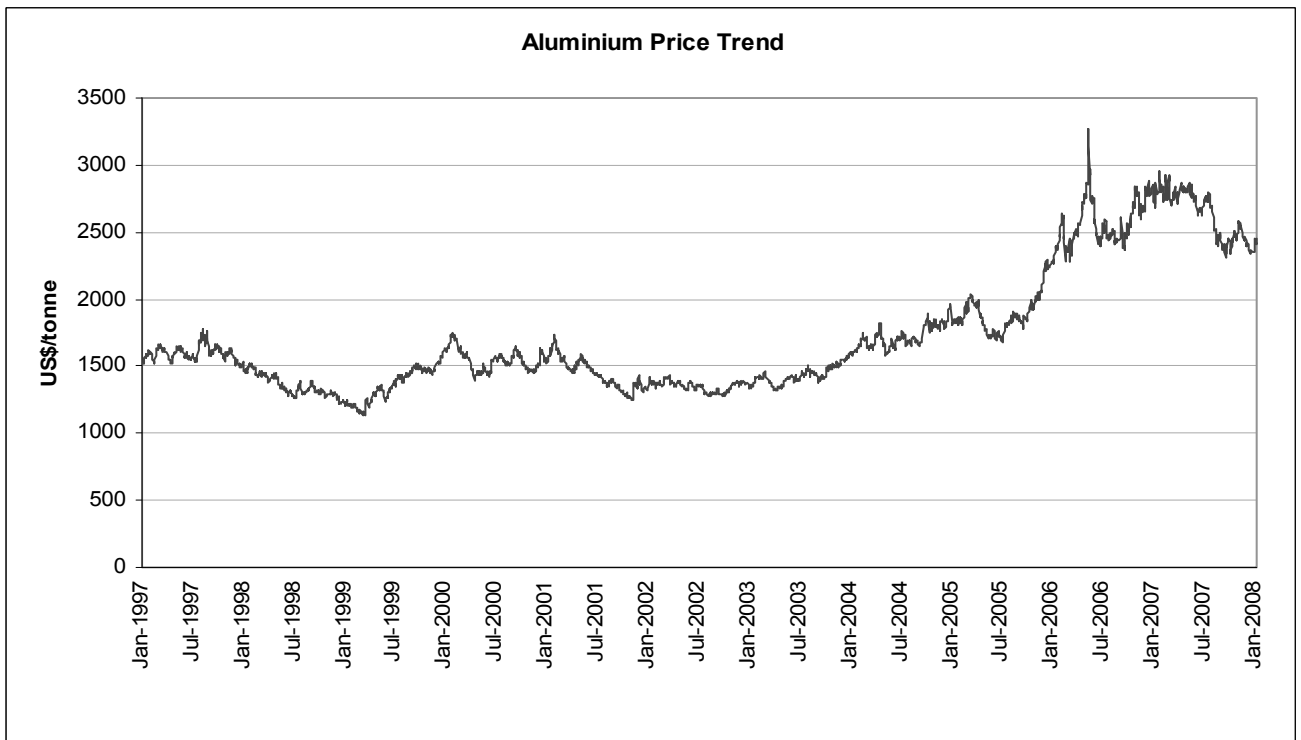
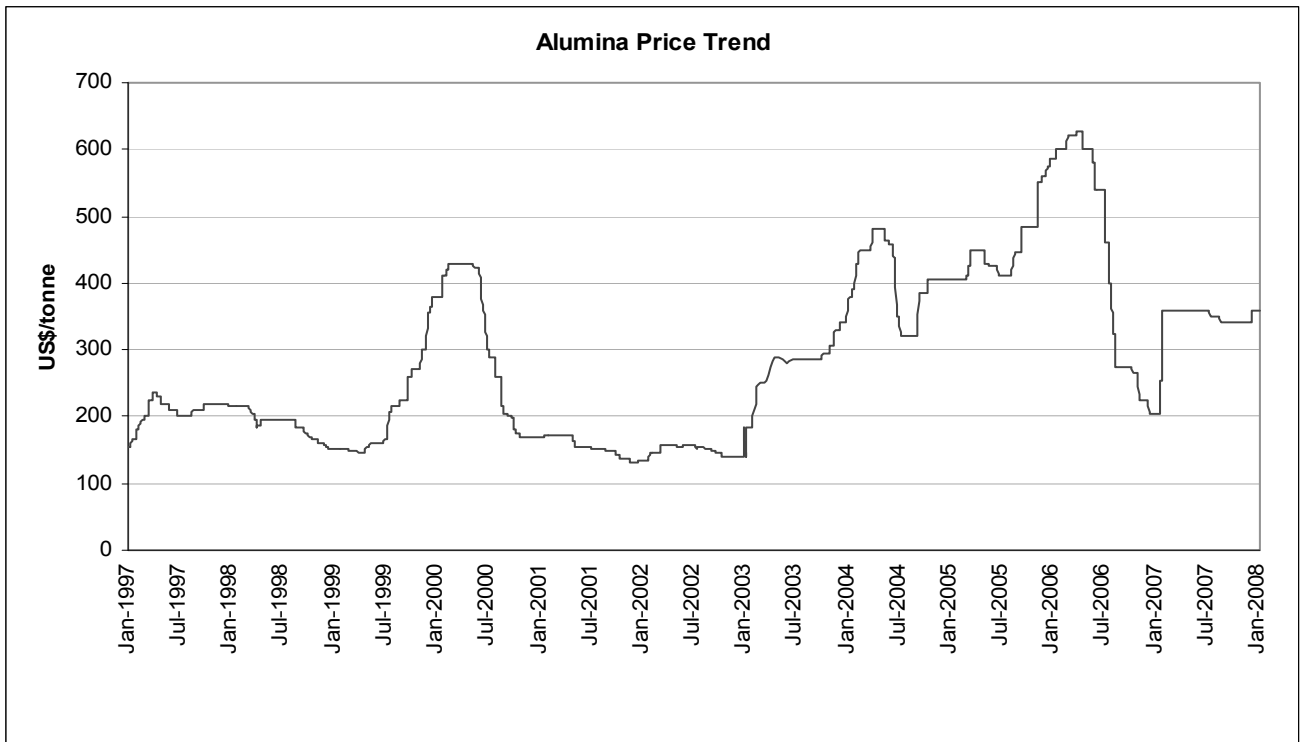
The world's largest aluminium metal producer is China, with 28 per cent of the world total. The next biggest producers are Russia, with 11 per cent, and Canada, with nine per cent. China's aluminium production has increased by 116 per cent since 2002. Mozambique also increased output significantly, rising by 106 per cent since 2002, Bahrain's grew by 69 per cent and India by 60 per cent, although these countries each had two or three per cent of the total world production in 2006. By contrast, aluminium production in the USA fell by 16 per cent in the five years since 2002.

Prices

Metallurgical grade bauxite and alumina are mostly traded on long-term contracts and typical prices are not published. During 2007, Chinese refractory grade bauxite generally traded in the range US\$130 to US\$160 per tonne, depending on the specification, with Guyanan refractory grade bauxite ranging from US\$165 to US\$235 per tonne (Tran, 2007b).

Spot prices for metallurgical grade alumina were relatively stable throughout 2007, at around US\$350 per tonne. This compares to a dramatic rise and fall that occurred in 2006 with prices reaching a high of over US\$600 per tonne in April 2006 and a low of nearly US\$200 per tonne in December 2006 (Metal Bulletin, 2008).

The London Metal Exchange official daily cash price for aluminium ingot showed a generally increasing trend from below US\$1500 per tonne in 2003 to nearly US\$3000 per tonne by mid-2007, despite a sharp fall in May 2005 and a spike in May 2006 (Metal Bulletin, 2008). In the latter half of 2007 the price fell to below US\$2500 per tonne as a result of weaker demand.



Industry events in 2007

The year started with the completion of the merger between the Russian producers Rusal and Sual, and the aluminium assets of Swiss-based Glencore International. This merger resulted in a new organisation, United Company Rusal, which is the largest alumina producer in the world. At the time they also claimed the top place in aluminium production, but only held this for a few months.

The largest ever takeover in the mining sector was completed in October, when Rio Tinto completed their US\$38.1 billion purchase of the Canada-based Alcan Inc. Rio Tinto Alcan is now the largest aluminium producer in the world, ahead of United Company Rusal. Rio Tinto Alcan is also the largest bauxite miner and a significant producer of alumina.

The other large producer of bauxite, alumina and aluminium is United States-based Alcoa Inc. They made their own (hostile) bid for Alcan Inc. in 2007, but were outbid by Rio Tinto. However, Alcoa retain a top three position in each commodity.

In May 2007, Alcoa's Technology Delivery Group revealed a new technology that is designed to substantially reduce the carbon footprint of the global aluminium industry. The system mixes carbon dioxide with bauxite residue from the refinery process thus preventing it from being released into the atmosphere. The process would also reduce the pH of the residue and allow it to be re-used as road filler. Although still at the pilot stage at a single plant in Western Australia, Alcoa intends to expand this new technology to all of its Australian operations, thus saving up to 300 000 tonnes per year of carbon dioxide emissions (Mining Journal, 2007a).

Production at some Chinese alumina refineries had to be cut back during the middle of the year partly as a result of insufficient supplies of bauxite. Although China is seeking to increase production of domestic bauxite it is still heavily dependent on imports, most of which come from Indonesia. Alumina refinery capacity in China is increasing more quickly than Indonesian bauxite production. Many refinery operators claimed the production cuts were also to support prices. However, in many countries plans are underway to increase alumina refinery capacity (Teo, 2007a).

The situation for Chinese refineries appeared to be made worse in August when some bauxite mines in west Bintan, one of Indonesia's two main bauxite mining areas, had their licences revoked. However, the companies involved reported their supplies were not affected (Teo, 2007b).

Production at the Jamalco alumina refinery in Jamaica was halted in August due to damage caused by Hurricane Dean. The refinery was restarted later in the year, but damage to port facilities caused problems in supplying aluminium smelters, such as Ormet's plant in Hannibal, Ohio, which had to delay the restart of one of its potlines (Mining Journal, 2007b; Metal Bulletin, 2007).

Work began in November for a new US\$5.6 million aluminium smelter in Qatar. The 585 000 tonnes per year capacity plant is a joint venture between Norsk Hydro and Qatar Petroleum, and will be the largest greenfield smelter ever built in one step (Teo, 2007c).

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Production of bauxite

tonnes

Country	2002	2003	2004	2005	2006
Bosnia & Herzegovina	71 300	573 000	916 900	1 031 600	816 768
France	150 000	170 000	170 000	175 000	160 000
Greece	2 492 000	2 418 000	2 396 065	2 441 443	2 162 900
Hungary	720 000	665 904	646 726	535 337	538 258
Montenegro	—	—	—	—	659 370
Russia	4 585 700	5 441 800	6 017 600	6 409 300	6 399 200
Serbia and Montenegro	611 500	540 051	610 000	672 345	—
Turkey	287 403	364 306	365 836	356 480	771 227
Ghana	683 654	494 716	498 060	606 700	841 775
Guinea	17 480 000	17 072 200	18 799 800	19 236 900	18 184 000
Mozambique	9 119	11 793	6 723	9 518	11 800
Sierra Leone	—	—	—	—	1 071 140
Tanzania	...	...	...	1 640	5 373
Jamaica	13 119 449	13 444 528	13 296 481	14 116 393	14 865 351
USA (b) (d)	*200 000	*200 000	259 870	121 187	361 047
Brazil (c)	13 147 900	18 456 800	20 511 800	22 034 600	22 836 300
Guyana	1 639 266	1 712 236	1 478 897	1 675 842	1 470 605
Suriname	4 001 602	4 215 061	4 087 107	4 756 998	4 945 353
Venezuela	5 190 806	5 445 516	5 814 705	5 900 000	*5 500 000
China	12 958 700	14 567 000	17 518 000	17 408 200	*21 000 000
India (f)	9 867 455	10 924 786	11 964 011	12 335 198	15 199 000
Indonesia	1 283 485	1 262 705	1 330 827	*2 000 000	*7 000 000
Iran (a)	323 600	391 388	420 000	437 595	*440 000
Kazakhstan	4 376 700	4 737 100	4 705 400	4 815 400	4 860 000
Malaysia	39 975	5 732	2 040	4 735	91 806
Pakistan (e)	12 233	4 098	4 847	6 504	7 831
Vietnam	*20 000	*20 000	*20 000	*20 000	*20 000
Australia	54 135 000	55 602 000	56 593 000	59 959 000	61 781 000
World Total	147 000 000	159 000 000	168 000 000	177 000 000	192 000 000

Note(s):-

(1) This table includes production of refractory bauxite

- (a) Years ended 20 March following that stated
- (b) Data for Alabama only
- (c) Including beneficiated and direct shipping ore
- (d) Years ended 30 September of that stated
- (e) Years ended 30 June of that stated
- (f) Years ended 31 March following that stated

Production of alumina

tonnes (Al₂O₃ content)

Country	2002	2003	2004	2005	2006
Azerbaijan	90 960	179 995	232 300	314 764	362 665
Bosnia & Herzegovina	—	35 011	*30 000	—	—
France	*500 000	*500 000	*500 000	*500 000	*500 000
Germany	*825 000	*830 000	*835 000	*830 000	*830 000
Greece	490 000	496 000	514 000	511 000	510 000
Hungary	293 700	300 000	304 000	*300 000	*300 000
Irish Republic	1 400 000	1 500 000	*1 500 000	*1 800 000	1 800 000
Italy	1 010 000	1 021 000	1 064 000	1 070 000	1 090 000
Montenegro	—	—	—	—	236 740
Romania	361 047	332 853	560 243	689 329	621 973
Russia	3 130 884	3 230 478	3 269 416	3 259 216	3 265 250
Serbia and Montenegro	237 396	239 739	245 005	235 196	—
Spain	1 350 000	1 380 000	*1 400 000	*1 400 000	*1 400 000
Turkey	152 869	160 675	169 991	112 558	140 089
Ukraine	1 350 900	1 434 050	1 562 970	1 632 020	1 671 620
United Kingdom	73 800	—	—	—	—
Guinea	669 835	723 026	778 000	729 600	555 000
Canada	1 283 000	1 269 600	1 328 842	1 400 340	1 476 959
Jamaica	3 630 587	3 843 610	4 022 722	4 085 634	4 099 548
USA	4 338 000	4 861 000	5 354 000	5 215 000	5 012 000
Brazil	3 855 400	4 713 800	5 126 500	5 201 100	6 720 200
Suriname	1 902 706	2 004 538	2 014 622	1 939 615	2 151 148
Venezuela	1 901 000	1 882 007	*1 900 000	1 931 000	1 920 000
China	5 449 600	6 112 100	6 980 000	8 512 000	13 696 000
India	2 556 000	2 856 000	2 974 000	3 005 000	3 080 000
Iran (a)	101 339	102 785	137 002	130 100	*130 000
Japan	723 900	725 000	780 000	*780 000	780 000
Kazakhstan	1 386 457	1 419 237	1 467 966	1 505 415	1 514 509
Australia	16 429 000	16 529 000	16 700 000	17 704 000	18 312 000
World Total	55 500 000	58 700 000	61 800 000	64 800 000	72 200 000

Note(s):-

(1) Where possible figures in this table show the alumina equivalent (Al₂O₃) of total hydrate produced, whether or not calcined

(a) Years ended 20 March following that stated

Production of primary aluminium

tonnes

Country	2002	2003	2004	2005	2006
Azerbaijan	58	18 565	29 537	31 762	31 852
Bosnia & Herzegovina	102 300	112 500	121 294	131 094	136 190
France	463 000	444 000	447 000	440 000	442 100
Germany	652 845	660 783	667 800	647 900	515 500
Greece	165 262	167 797	166 634	165 300	165 000
Hungary	35 294	34 000	34 300	31 000	300
Iceland	285 394	286 022	284 700	273 318	328 424
Italy	190 400	191 400	195 400	192 900	194 200
Montenegro	—	—	—	—	121 762
Netherlands	284 364	282 800	330 000	333 820	285 317
Norway	1 044 000	1 180 200	1 318 000	1 390 000	1 381 000
Poland	58 777	57 145	58 931	54 508	57 620
Romania	187 052	196 844	222 347	243 605	258 300
Russia	3 348 247	3 478 057	3 594 747	3 647 061	3 717 907
Serbia and Montenegro	111 919	116 744	115 080	116 994	—
Slovakia	111 600	132 089	156 893	158 400	158 289
Slovenia	87 600	109 800	120 700	138 500	139 600
Spain	380 100	389 100	397 500	395 000	367 400
Sweden	100 125	100 707	100 591	102 107	101 668
Switzerland	40 224	43 865	44 879	44 800	12 000
Turkey	62 501	63 140	64 002	59 000	60 000
Ukraine	112 459	113 640	113 212	114 213	112 961
United Kingdom	344 318	342 748	359 631	368 477	360 325
Cameroon	67 000	77 200	85 900	90 400	87 000
Egypt	195 000	194 600	216 000	243 800	252 300
Ghana	131 858	15 909	—	13 400	75 800
Mozambique	273 200	407 400	547 100	553 700	564 000
South Africa	706 916	732 717	866 074	846 213	895 000
Canada	2 708 910	2 791 915	2 592 160	2 894 204	3 051 128
Mexico	39 000	17 600	—	—	—
USA	2 707 000	2 703 300	2 516 400	2 481 000	2 283 100
Argentina	267 776	273 524	273 575	275 071	268 805
Brazil	1 318 400	1 380 600	1 457 400	1 497 600	1 604 500
Venezuela	604 000	601 290	631 100	624 000	617 100
Bahrain	517 004	526 000	530 000	749 987	872 393
China	4 321 000	5 546 900	6 688 800	7 806 000	9 349 000
Dubai	538 000	560 000	683 000	724 565	789 341
India (b)	688 921	810 282	883 960	930 543	*1 100 000
Indonesia	162 800	197 300	240 800	252 300	250 300
Iran (a)	169 491	182 477	212 602	218 754	*240 000
Japan	6 413	6 463	6 433	6 400	6 400
Tajikistan	307 589	319 360	358 082	379 630	413 800
Australia	1 836 000	1 857 000	1 895 000	1 903 000	1 931 000
New Zealand	333 900	334 970	350 299	351 449	337 300
World Total	26 000 000	28 000 000	30 000 000	31 900 000	33 900 000

Note(s):-

(a) Years ended 20 March following that stated

(b) Years ended 31 March following that stated

Mine production of antimony

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Russia	*3 000	*3 000	*3 000	*3 000	*3 000
Turkey	*150	*400	*700	*1 200	*1 200
South Africa	5 746	5 291	4 967	5 979	*4 500
Canada	173	153	105	79	90
Guatemala	401	2 000	2 686	1 007	*1 000
Mexico	155	434	503	565	778
Bolivia	2 343	2 432	3 036	5 204	5 460
Peru (a)	352	616	465	807	1 395
China	121 547	100 000	125 433	151 457	150 100
Kyrgyzstan	*1 500	*1 200	*1 500	*1 500	*1 500
Pakistan (b)	37	...	—	5	91
Tajikistan	*3 000	*3 000	4 069	4 073	3 480
Thailand	13	46	61	415	1 639
Australia (b)	1 838	206	157	192	*250
World Total	140 000	119 000	147 000	175 000	174 000

Note(s):-

(1) This table includes antimony content of antimonial lead alloys

(2) In addition, Hungary is believed to produce antimony

(a) Including Sb content of antimonial lead plus Sb content of ores for export

(b) Years ended 30 June of that stated

Production of white arsenic

tonnes

Country	2002	2003	2004	2005	2006
Belgium	*1 000	*1 000	*1 000	*1 000	*1 000
France	*1 000	*1 000	*1 000	*1 000	*1 000
Germany	*200	—	—	—	—
Portugal	*50	*50	*50	*50	*50
Russia	*1 500	*1 500	*1 500	*1 500	*1 500
Namibia (a)	852	389	1 264	29	—
Canada	*250	*250	*250	*250	*250
Mexico	2 569	2 283	2 415	2 197	2 106
Bolivia	237	276	168	120	120
Chile (c)	*10 000	*10 000	*10 000	*10 000	*10 000
Peru	1 613	4 640	3 037	3 150	4 399
China	*40 000	*40 000	*30 000	*30 000	*30 000
Iran (b)	142	275	89	*100	*100
Japan	*40	*40	*40	*40	*40
Kazakhstan	*1 500	*1 500	—	—	*1 500

Note(s):-

(1) This table includes calculated trioxide equivalent of arsenic metal produced except where this would involve double counting

(2) In addition to the countries listed, Austria, Finland, Hungary, Spain and the United Kingdom are believed to produce arsenic

(a) Output of Tsumeb Corp. only, trioxide equivalent of reported black arsenic

(b) Orpiment and realgar concentrates

(c) Exports

Production of asbestos

tonnes

Country	2002	2003	2004	2005	2006
Greece	—	*13 000	*4 000	—	—
Russia	785 142	883 888	923 000	*925 000	*925 000
Serbia	—	—	—	—	*100
Serbia and Montenegro	372	111	370	*100	—
South Africa					
Chrysotile	13 311	6 218	—	—	—
Zimbabwe					
Chrysotile	167 954	143 087	104 457	122 041	96 956
Canada					
Chrysotile	242 241	200 500	200 000	*200 000	240 000
USA (a)	2 720	—	—	—	—
Argentina	155	166	267	260	299
Brazil	194 732	231 115	252 067	236 047	227 304
Colombia (c)	62 785	*60 000	*60 000	*60 000	*60 000
China	*480 000	*430 000	438 962	332 407	458 000
India					
Amphibole (e)	14 139	10 107	6 392	2 366	415
Iran (d)	2 400	1 470	1 300	1 300	*1 300
Kazakhstan	291 200	353 000	346 500	305 500	*300 000
Pakistan (b)	100	60	380	—	—
World Total	2 300 000	2 300 000	2 300 000	2 200 000	2 300 000

Note(s):-

(1) In addition to the countries listed, Romania is believed to produce asbestos

(a) Sold or used by producers

(b) Years ended 30 June of that stated

(c) Crude

(e) Years ended 31 March following that stated

(d) Years ended 20 March following that stated

Production of barytes

tonnes

Country	2002	2003	2004	2005	2006
Bosnia & Herzegovina	*2 000	*1 900	*1 900	*200	*200
Bulgaria	123 200	91 200	75 400	79 500	91 000
France	85 200	81 100	81 000	*81 000	*40 000
Georgia	1 042	—	—	—	—
Germany	100 993	109 506	93 624	88 591	85 524
Italy	10 215	12 214	12 258	7 312	*7 000
Poland	2 708	3 030	3 183	2 357	2 034
Romania	100	23	—	—	—
Russia	58 900	79 000	63 400	63 400	63 000
Slovakia	25 820	12 000	27 063	26 589	25 800
Spain	50 071	44 660	40 776	44 643	45 000
Turkey	106 943	119 648	134 504	70 925	*71 000
United Kingdom	*59 000	*57 000	*61 000	*62 000	*47 000
Algeria	51 773	47 340	47 753	54 773	64 787
Morocco	487 626	358 496	355 800	475 700	612 800
Nigeria	*5 000	*15 000	*15 000	*30 000	*30 000
Tunisia	5 539	2 600	1 813	—	—
Zimbabwe	5 233	4 676	3 486	—	—
Canada	15 000	27 000	21 000	23 000	21 000
Mexico	163 620	287 451	306 668	268 657	199 605
USA (b)	420 000	468 000	532 000	589 000	*540 000
Argentina	3 048	6 934	2 762	3 355	6 276
Bolivia	15 556	1 851	5 774	11 379	8 943
Brazil (d)	53 098	57 452	50 430	42 924	47 611
Chile	384	229	31	91	375
Colombia	*600	*2 400	*2 000	*2 000	*2 000
Ecuador	...	2 139	3 694	3 879	*4 000
Peru	3 806	2 906	9 610	26 985	1 899
Afghanistan	*2 000	*2 000	*2 000	*1 500	*1 500
Burma	15 100	4 900	2 200	2 100	2 000
China	2 700 000	3 300 000	3 700 000	4 100 000	4 600 000
India (a)	679 628	723 075	1 159 031	1 189 839	1 475 926
Iran (c)	193 579	196 169	207 466	231 184	230 000
Kazakhstan	51 700	78 000	310 700	268 700	*270 000
Korea, Dem. P.R. of	*70 000	—	—	—	—
Laos	12 695	18 070	10 500	1 000	10 000
Malaysia	3 082	—	—	—	910
Pakistan (e)	19 480	40 745	44 071	42 087	44 183
Saudi Arabia	9 000	10 800	30 000	30 000	31 000
Thailand	137 469	115 600	211 278	115 000	50 000
Vietnam	60 200	81 500	101 000	116 000	90 000
Australia	*19 000	*22 000	*29 000	18 020	17 167
World Total	5 800 000	6 500 000	7 800 000	8 200 000	8 800 000

Note(s):-

- (1) This table may include small quantities of witherite
- (2) In addition to the countries listed, Cuba is believed to produce barytes

- (a) Years ended 31 March following that stated
- (b) Sold or used by producers
- (c) Years ended 20 March following that stated
- (d) Including beneficiated and directly shipped material
- (e) Years ended 30 June of that stated

Production of bentonite and fuller's earth

tonnes

Country	2002	2003	2004	2005	2006
Armenia					
Bentonite	328	642	561	732	720
Azerbaijan					
Bentonite	1 500	19 900	55 000	53 700	40 600
Bosnia & Herzegovina					
Bentonite	9 829	16 967	24 353	24 882	24 050
Bulgaria					
Bentonite	211 500	145 500	224 900	181 200	134 500
Croatia					
Bentonite	12 102	13 568	15 674	17 391	16 410
Cyprus					
Bentonite	128 400	144 859	155 717	172 366	150 620
Czech Republic					
Bentonite	174 000	199 000	201 000	186 000	220 000
Denmark					
Bentonite	14 539	16 303	18 352	18 515	19 211
Georgia					
Bentonite	*7 000	9 747	1 804	7 876	4 487
Germany					
Bentonite	495 310	478 796	404 549	352 374	363 998
Greece					
Bentonite	1 056 598	1 156 642	1 030 556	1 124 795	*1 100 000
Hungary					
Bentonite	3 700	87 200	9 300	4 900	6 635
Italy					
Bentonite	463 231	474 475	371 255	341 049	...
Fuller's earth	24 595	250	300	...	...
Macedonia					
Bentonite	17 420	6 013	16 373	14 958	20 353
Poland					
Bentonite	—	—	—	—	93 880
Romania					
Bentonite	15 389	17 637	18 161	18 190	20 299
Russia					
Bentonite	*500 000	*500 000	*500 000	*500 000	*500 000
Slovakia					
Bentonite	65 500	74 700	73 280	77 055	95 700
Spain					
Bentonite	123 457	103 174	156 760	162 333	*160 000
Attapulгите	22 918	18 975	20 796	20 565	*20 000
Sepiolite	564 610	548 728	655 346	718 364	...
Turkey					
Bentonite	559 224	831 146	643 153	582 735	*600 000
Sepiolite	*10 000	*10 000	*10 000	*10 000	*10 000
Ukraine					
Bentonite	*25 000	*25 000	*25 000	*25 000	*25 000
United Kingdom					
Fuller's earth (a)	44 200	33 900	27 540	6 200	—
Algeria					
Bentonite	30 699	28 064	32 200	29 029	27 110
Fuller's earth	3 521	2 573	2 284	831	—
Egypt					
Bentonite	...	...	...	6 320	*6 300
Morocco					
Bentonite	58 754	71 544	...	...	...
Fuller's earth (f)	43 243	14 944	*15 000	*15 000	*15 000
Mozambique					
Bentonite	580	684	578	547	610
Senegal					
Attapulгите	176 454	176 857	*180 000	*180 000	*180 000
South Africa					
Bentonite	98 313	145 060	55 859	139 883	32 878
Attapulгите	13 918	14 585	20 419	34 340	49 225

Production of bentonite and fuller's earth

tonnes

Country	2002	2003	2004	2005	2006
Guatemala					
Bentonite	12 415	6 438	...	...	...
Mexico					
Bentonite	488 215	464 056	564 015	425 630	435 273
Fuller's earth	147 064	152 917	129 502	107 265	102 400
Nicaragua					
Bentonite	*6 000	*6 300	*6 300	*6 300	*6 300
USA					
Bentonite (c)	*3 790 000	3 770 000	4 060 000	4 710 000	*4 620 000
Fuller's earth (c)	*2 730 000	3 610 000	3 260 000	2 990 000	*2 980 000
Argentina					
Bentonite	120 006	146 845	163 028	247 101	256 165
Fuller's earth	*1 500	*1 500	*1 500	*1 500	*1 500
Brazil					
Bentonite	304 782	392 422	432 224	459 679	419 214
Chile					
Bentonite	632	748	101	—	—
Colombia					
Bentonite	*8 500	*8 500	*8 500	*8 500	*8 500
Peru					
Bentonite	20 760	15 290	10 510	14 663	14 590
Burma					
Bentonite (b)	1 104	856	*800	*800	*800
China					
Bentonite	2 180 000	2 200 000	2 250 000	2 300 000	3 200 000
India					
Bentonite (b)	*250 000	*200 000	*410 000	*590 000	...
Fuller's earth (b)	*62 000	*76 000	*144 000	*93 000	...
Indonesia					
Bentonite	*5 000	*5 000	*5 000	*5 000	*5 000
Iran					
Bentonite (d)	157 571	186 422	176 425	261 888	...
Japan					
Bentonite	437 772	425 945	455 282	*450 000	*450 000
Fuller's earth	117 099	123 545	109 657	*110 000	*110 000
Korea, Republic of					
Bentonite	89 905	40 095	99 173	85 177	61 137
Fuller's earth	18 757	32 685	26 487	84 632	46 314
Pakistan					
Bentonite (e)	17 799	9 432	6 316	15 671	20 088
Fuller's earth (e)	15 951	14 723	13 986	17 001	16 209
Philippines					
Bentonite	2 550	3 722	3 556	*3 600	*3 600
Thailand					
Bentonite	1 700	1 100	1 350	32 500	1 200
Uzbekistan					
Bentonite	*15 000	*15 000	*15 000	*15 000	*15 000
Vietnam					
Bentonite	*20 000	*20 000	*20 000	*20 000	*20 000

Production of bentonite and fuller's earth

tonnes

Country	2002	2003	2004	2005	2006
Australia					
Bentonite (e)	113 047	144 755	264 038	*223 000	*135 000
Fuller's earth	11 926	11 187	10 142	9 784	*10 000
New Zealand					
Bentonite	7 800	10 940	10 050	7 590	3 028
World Total Bentonite	12 100 000	12 600 000	13 000 000	14 000 000	14 600 000
World Total Fullers Earth (g)	4 000 000	4 800 000	4 600 000	4 400 000	4 400 000

Note(s):-

- (1) Bentonites consist of montmorillonite (one of the smectite group of clay minerals) and occur in two main varieties, calcium bentonite, the most commonly occurring, and sodium bentonite, industrially the more important
 - (2) Calcium bentonite can be converted to sodium bentonite by a sodium-exchange process
 - (3) In some countries, such as the United Kingdom, calcium bentonite is known as fuller's earth, a term which is also used to refer attapulgite, a mineralogically distinct clay mineral but exhibiting similar properties
 - (4) In addition to the countries listed, Austria is believed to produce bentonite and France may produce fuller's earth
- (a) Saleable production based on data from producing companies
 - (b) Years ended 31 March following that stated
 - (c) Sold or used by producers
 - (d) Years ended 20 March following that stated
 - (e) Years ended 30 June of that stated
 - (f) Smectite
 - (g) Including attapulgite and sepiolite

Production of beryl

tonnes

Country	2002	2003	2004	2005	2006
Madagascar (a)	1	*1	12	*12	*12
Mozambique	54	78	45	146	130
Uganda	...	...	207	19	*20
Zambia	7	7	7	*7	*7
USA	1 970	2 100	2 210	2 780	3 830
Brazil	*4	*4	*4	*4	*4
China	*500	*500	*500	*500	*500

Note(s):-

- (a) Includes ornamental and industrial products

Mine production of bismuth

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Bulgaria	*40	*40	*40	*40	*40
Romania	*40	*40	*40	*40	*40
Russia	*50	*50	*50	*50	*50
Canada	244	166	223	170	222
Mexico	1 126	1 064	1 014	970	1 186
Bolivia	20	72	62	44	155
Peru (b)	568	832	988	952	1 081
China (a)	944	1 036	1 857	1 886	1 900
Japan (b)	474	513	522	463	425
Kazakhstan	161	*150	—	—	—
Australia	*100	*100	*100	*100	*100
World Total	3 800	4 000	4 900	4 700	5 200

Note(s):-

- (1) The figures in this table are in some instances derived from reported bismuth content of refined and impure metal plus recoverable in ores and concentrates exported
 - (2) Production for some countries may include bismuth produced from imported ores but it is thought that any resulting duplication is insignificant in the countries shown
 - (3) In addition to the countries listed, Brazil is believed to produce bismuth
- (a) Exports of metal have always been higher than mine production in recent years
(b) Metal production

Production of borates

tonnes

Country	2002	2003	2004	2005	2006
Russia	*1 000 000	*1 000 000	*500 000	*400 000	*400 000
Turkey	1 328 000	1 324 000	1 727 000	2 087 000	2 373 345
USA (a)	1 050 000	1 150 000	1 210 000	1 150 000	*1 150 000
Argentina	515 555	512 167	821 031	632 792	533 535
Bolivia	40 479	109 545	68 031	63 499	50 727
Chile	431 293	400 603	594 191	460 683	459 645
Peru	8 814	11 072	9 729	8 290	*9 000
China	*283 000	*270 000	*275 000	*280 000	*280 000
Iran (b)	2 074	2 126	2 142	1 660	...
Kazakhstan	27 100	*30 000	*30 000	*30 000	*30 000

Note(s):-

- (a) Sold or used by producers
- (b) Years ended 20 March following that stated

Production of bromine

kilograms

Country	2002	2003	2004	2005	2006
France	*8 000 000	*8 000 000	*8 000 000	*8 000 000	*8 000 000
Germany	*500 000	*500 000	—	—	—
Italy	*300 000	*300 000	*300 000	*300 000	*300 000
Russia	*60 000	*60 000	*60 000	*60 000	*60 000
Spain	*100 000	*100 000	*100 000	*100 000	*100 000
Ukraine	846 000	1 324 000	1 878 000	3 138 000	*700 000
United Kingdom	24 542 000	*25 000 000	—	—	—
USA (a)	222 000 000	216 000 000	222 000 000	226 000 000	*226 000 000
China	*42 000 000	*42 000 000	*43 000 000	*43 000 000	*44 000 000
India	1 579 000	1 560 000	1 730 000	2 420 000	2 130 000
Israel	185 000 000	176 000 000	202 000 000	207 048 000	179 493 000
Japan	*20 000 000	*20 000 000	*20 000 000	*20 000 000	*20 000 000
Jordan	—	—	46 339	89 785	94 500
World Total	505 000 000	491 000 000	499 000 000	510 000 000	481 000 000

Note(s):-

(a) Elemental bromine sold as such or used in the preparation of bromine compounds by primary producers

Production of cadmium

tonnes

Country	2002	2003	2004	2005	2006
Belgium	117	—	—	—	—
Bulgaria	345	307	356	319	*300
Finland	400	—	—	—	—
France	154	*120	*120	*100	*100
Germany	422	640	*640	*640	*640
Italy	362	22	—	—	—
Macedonia	111	75	—	—	—
Netherlands	485	495	572	*570	*560
Norway	215	323	141	153	125
Poland	440	375	356	408	373
Russia	*650	*650	*650	*650	*650
United Kingdom	292	22	—	—	—
Canada (a)	1 706	1 759	1 880	1 727	2 094
Mexico	1 382	1 590	1 594	1 627	1 399
USA (a)	1 432	1 416	1 013	1 070	892
Argentina	—	25	39	56	...
Brazil	151	189	187	200	*200
Peru	422	530	532	481	416
China	2 426	2 705	4 528	4 077	*4 600
India (b)	483	478	480	406	*480
Japan	2 444	2 509	2 233	2 297	2 286
Kazakhstan	479	930	2 358	1 624	*2 000
Korea, Dem. P.R. of	*200	*200	*200	*200	*200
Korea, Republic of	1 827	2 175	2 362	2 582	3 320
Australia	524	673	469	429	425
World Total	17 500	18 200	20 700	19 600	21 100

Note(s):-

(1) Data in this table excludes secondary metal unless otherwise stated

(a) Including cadmium sponge and/or secondary metal

(b) Years ended 31 March following that stated

Production of chromium ores and concentrates

tonnes

Country	2002	2003	2004	2005	2006
Albania	72 600	98 000	160 300	170 000	201 120
Finland	566 090	549 000	580 000	572 000	549 000
Russia	71 000	169 200	447 300	772 000	966 095
Turkey	326 390	281 783	436 639	688 377	457 893
Madagascar	10 737	45 040	77 386	140 847	132 335
South Africa	6 435 746	7 405 391	7 676 799	7 502 762	7 418 326
Sudan	14 000	37 000	26 000	21 654	28 772
Zimbabwe	725 822	572 558	668 391	614 720	700 001
Cuba	20 400	34 300	40 300	34 000	*34 000
Brazil	283 991	376 862	593 476	616 534	562 739
Afghanistan	6 136	6 364	6 591	—	—
Burma (a)	*3 000	*3 000	*3 000	*3 000	*3 000
China	164 200	197 800	230 000	220 000	220 000
India (a)	3 068 631	2 904 809	3 621 394	3 422 880	3 957 000
Iran (b) (c)	232 068	150 316	134 872	234 376	244 603
Kazakhstan	2 369 500	2 927 900	3 287 100	3 581 242	3 366 078
Oman	27 400	13 800	24 300	18 386	70 500
Pakistan (d)	16 679	30 657	29 230	56 359	64 572
Philippines (b)	22 000	33 778	42 139	36 070	*50 000
United Arab Emirates	—	—	7 089	—	—
Vietnam	66 300	91 000	82 000	89 000	*90 000
Australia	57 142	67 271	110 273	90 260	107 103
World Total	14 600 000	16 000 000	18 300 000	18 900 000	19 200 000

Note(s):-

(1) In addition to the countries listed, Bulgaria is believed to produce chromite

- (a) Years ended 31 March following that stated
- (b) Including foundry sand and/or lumpy ore
- (c) Years ended 20 March following that stated
- (d) Years ended 30 June of that stated

COAL

Characteristics

Coal is a combustible sedimentary rock made of lithified plant remains. A coal seam is formed by the alteration of dead plant material that initially accumulates as peat on the land surface. As the peat becomes buried beneath younger sediments the temperature increases with increasing depth of burial. Peat is sequentially altered by the process of 'coalification', a process involving the loss of water and volatile components, through brown coals to black coals.

The physical and chemical properties of coal, that is coal quality, determine whether a coal can be used commercially. Calorific value, or the heat energy given off by the combustion of a unit quantity of fuel is one of the main quality criteria used by coal consumers. Coal quality is important as it affects the operation of plant, and thus the costs of generating power, through its impact on the costs of both maintenance and conformity with environmental legislation. Chlorine and sulphur are both detrimental in coal, causing pollution as well as corrosion in boilers.

Based on the physical properties of different bituminous coals, a fundamental distinction is made worldwide between steam coal (or thermal coal), used for burning in boilers, chiefly for electricity generation, and coking coal, which is used to make coke for the metallurgical industries. Coking coal produces coke with sufficient strength to support the loads imposed within a blast furnace. Steam coal tends to have calorific values at the lower end of the range.

Uses

Power generation is the primary use for coal. Roughly 40 per cent of electricity, worldwide, is generated from coal and this may be considerably higher in many individual countries. In the US, for example, a little over half of the electricity generated is through coal-fired power stations and in China, 70 per cent. Approximately 25 per cent of world primary energy consumption is from coal.

Almost two-thirds of world steel production is made from iron produced in blast furnaces which use coal, mainly in the form of coke. Coke is made from coking coals, which are characterised by their chemical and physical properties: they are low in sulphur and phosphorus, liquefy when heated in the absence of air and solidify into hard, porous lumps. The lumps of coke are produced by processing coal in a series of coke ovens with an oxygen-deficient atmosphere in order to concentrate the carbon. The coke has a high energy value and provides the permeability, heat and gases which are required to reduce and melt the iron ore, pellets and sinter consumed in iron-making. Another, less-used, method is pulverised coal injection, which can utilise a wide range of coals, including the less-expensive steam coal. About a third of world steel production is produced from scrap in electric arc furnaces, and it follows that much of the electricity for this process is produced from coal.

Liquid fuels derived from coal are sulphur-free and have low levels of nitrogen oxides and particulate matter. Coal may be converted into liquid fuel (and other products such as waxes, lubricants and chemicals) by two methods: direct liquefaction, where coal is dissolved in solvents at high temperature and pressure; and indirect liquefaction, which gasifies the coal to produce a 'syngas' which is then condensed over a catalyst (the Fischer-Tropsch process). The Fischer-Tropsch process produces a clean, high-quality product, whilst the liquid fuel

produced through the direct process requires further refining. The South African company, Sasol, is the sole producer of liquid fuel and chemicals from coal on a commercial scale. The first coal liquefaction project in China, in the Inner Mongolia Province of China, is due to commence operation in 2008. Three companies, Shenua Group Corp., Jiali Chemical Ltd, and Baotou Mingtian Science and Technology Co. Ltd, invested in this project which will produce liquids from coal by direct liquefaction. Its aim is to reduce China's reliance on crude oil imports by 10 per cent or more. Projects are also under way or planned in the USA and Australia, and projects are being considered in Indonesia, India and Germany (Copley, 2007).

Coal is used as an energy source in cement production – a process that requires a large amount of energy. The coal consumed is half the mass of cement produced. Coal may also be gasified to produce a combination of hydrogen and carbon monoxide, which may be used for a range of purposes such as industrial heating, electricity generation and manufacture of chemicals. It is the source of numerous chemicals, as by-products, which are used in soap, pharmaceutical products, solvents, plastics, dyes and synthetic fibres. Coal is used in alumina refineries and in the production of activated carbon, carbon fibre and silicon metal.

World production in 2006

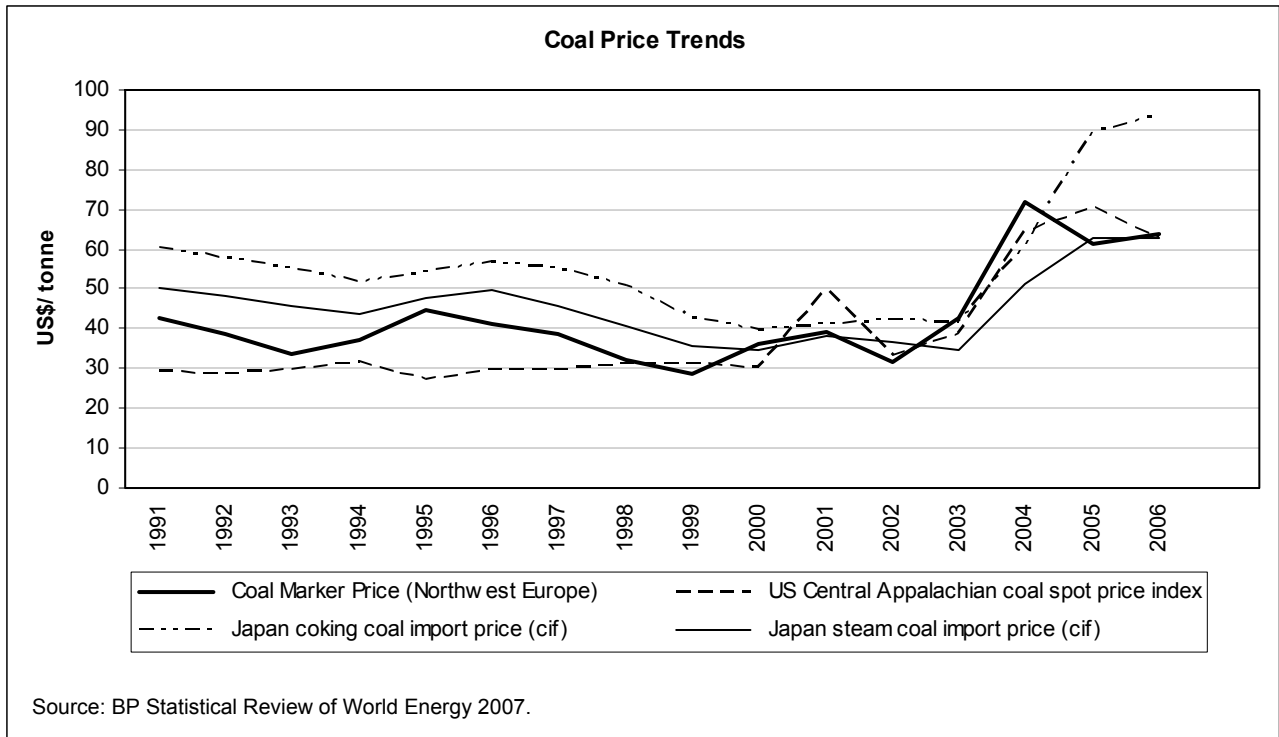
World coal production in 2006 was 6194 million tonnes. This was a five per cent increase on 2005. Production increased steadily during the period 2002 to 2006, with an overall increase of 29 per cent. China was the top-producing country with 2380 million tonnes. This represents a nine per cent increase on 2005 and a 68 per cent increase since 2002. The USA was the second largest producer with 1054 million tonnes and India, third, with production of 462 million tonnes.

For many countries experiencing steady and rapid economic growth, availability of low-cost coal has been a key factor in large-scale electrification and this is driving demand and increased production. China is now 99 per cent electrified, and 77 per cent of the electricity is produced in coal-fired power stations. The BBC reported that about two large coal-fired power stations were being built every week in China (Harrabin, 2007). This raises concerns about emissions, particularly the raised carbon dioxide concentrations, and health and safety matters. In 2006, 6000 deaths were officially recorded in coal mines in China.

Asia showed the fastest increases in coal production. Overall, there was an eight per cent increase in 2006 compared to 2005, and 53 per cent since 2002. Although much of this was due to the Chinese output, other countries have significantly increased their production. For 2002 to 2006, Indian production increased by 26 per cent, Indonesia by 71 per cent and Mongolia by 110 per cent.

Coal production in Europe, excluding Russia, has largely been stable during 2002 to 2006, falling by only two per cent to 809 million tonnes. Russia, the world's fifth largest producer, has increased production by 21 per cent from 256 million tonnes to 309 million tonnes.

African production is dominated by South Africa, the sixth largest coal-producing country in the world. Production of 245 million tonnes by South Africa represents an 11 per cent increase from 2002 to 2006. Coal production in the Americas has increased by eight per cent over the same time span, with



Colombia showing the largest increase of 66 per cent from 39 to 66 million tonnes. Australian production (the fourth largest producer) increased by 13 per cent.

Prices

The pricing of coal is complex, based on coal type, net calorific value and content of impurities such as sulphur. Additionally, the cost of transportation comprises a large proportion of the delivered price of coal. Coal is chiefly sold under long-term contracts that 'fix' the price of coal over the term of the contract, usually with an escalator based on inflation. Prices are normally quoted on a well-established world spot market.

A range of prices for different coal types and markets is given in the *BP Statistical Review of World Energy 2007*. For 2006, the Northwest Europe marker price, the US Central Appalachian coal spot price index and Japan steam coal import cif price are all around US\$63 per tonne, while the Japan coking coal import cif price was US\$93.46. Figure 1 shows their variation over time.

Some organisations, such as the globalCOAL RB Index, base their price on a basket of different coal-type prices and incorporate an element of bid/offer data. The fob price of steam coal in international trade, in terms of globalCOAL's Richards Bay (RB) Monthly Index, increased from US\$29.36/tonne in January 2002 to US\$94.46 in December 2007, with a particularly rapid increase of 50 per cent between September and December. The price increases in 2007 are attributed mainly to the surge in demand from Asia and high freight rates.

Industry events in 2007

There is a drive within government to close down dangerous and inefficient small coal mines in China. Reports of the numbers closed in 2007 vary, but are in the thousands. New pricing mechanisms are being introduced to enable producers to introduce new technology and to force small mines out of business. Latest coal industry policy states that new mines with an annual production capacity of less than 300 000 tonnes

will not be approved while, in mining provinces, new mines must have a minimum annual production capacity of 1.2 million tonnes (Mineweb, 3 January 2007). Coal companies are also being encouraged to invest in foreign coal resources.

The United Nations Development Programme commenced a US\$14.4 million project entitled *Strengthening coal mine safety standards in China* to include comparative studies on legislation and inspection relating to coal mine safety; improvement of standards relating to technical aspects, coal mine design, and appropriate economic and financial policies; development of systems for township and village mines (where the fatality rate is almost twice the national average); adoption of advanced gas control technology and equipment; and safety education in township and village mines.

Shenhua Energy Co., China's largest coal producer, commenced trading on the Shanghai Stock Exchange in October 2007 and nearly doubled its opening share price, raising a record US\$8.9 billion.

China, although the world's largest producer of coal, is now a net importer.

Australian producers experienced problems due to congestion at ports and railways in Queensland and New South Wales with large numbers of ships queuing to be loaded. The demand for coal exports exceeded port capacity and, as a consequence, shipping quotas had to be reduced relative to those originally requested. Many companies, including major producers such as Rio Tinto and Xstrata, were affected. Capacity at Newcastle Port, New South Wales, is being expanded to around 150 million tonnes annually – a 50 per cent increase on present capacity – but work will not be completed until 2009–10. In addition to these problems, tropical storms caused significant disruption in June.

In December, Rio Tinto announced a new investment of US\$991 million to extend its Kestrel Mine in the Bowen Basin region of Queensland, Australia, in order to increase the company's share of the growing demand for exported coal, particularly for Asian markets. The extension, which is subject

to government approvals, would increase the life of the mine and increase annual coal production to around 5.7 million tonnes. Rio Tinto and joint venture partners have also approved investment of US\$750 million to develop the Clermont mine in central Queensland to replace the Blair Athol Mine. Clermont, Rio Tinto reports, will become Australia's largest thermal coal producer when it reaches full capacity, which is scheduled for 2013.

Other industry activities specifically related to Asian demand include the investment of US\$79 million by a South Korean consortium for a ten per cent share of the Moolarben mine, New South Wales, thereby securing 2.8 million tonnes of coal annually from 2009. This consortium, led by Kores, will have access to this coal at cost, which is roughly half the market price (Reuters, 7 January 2007). Bowen Energy Ltd, a new company, plans to develop two mines for coking coal in Queensland with Bhushan Steel, an Indian steel producer (ABC News 14/08/07). In December, BHP Billiton announced completion of the sale of its Elouera mine, part of the Illawarra Coal business located in New South Wales, to Gujarat NRE FCGL Pty. Ltd for US\$41 million. BHP Billiton completed operations at this mine in 2005, after which it was operated under a limited contract mining agreement with Delta Mining Company until March 2007.

Xstrata agreed to buy the Anvil Hill project and Austral Coal from Centennial Coal for around US\$800 million. These mines produce thermal coal for power stations and coking coal, respectively. For a similar price, Xstrata also bought Resource Pacific Ltd.

US coal exports in 2007 are expected to have increased due to a combination of factors including the weak US dollar, the Australian port problems, and high demand. As US coal was relatively inexpensive at US\$47, European consumers were willing to pay the freight costs of US\$50 to ship it across the Atlantic (Martin, 2007).

Anglo American plc has approved a new project in South Africa. The Zondagsfontein mine, costing US\$505 million, is scheduled to be in production in the latter half of 2009. It is projected to produce six million tonnes per year for 20 years. This mine will share coal washing facilities with BHP Billiton's Klipspruit mine, which is being expanded. Anglo American plc has sold a 27 per cent, US\$973.6 million, stake in its South African coal assets to a black investor company and formed Anglo Inyosi, in a black economic empowerment (BEE) deal. Anglo Inyosi includes several key Anglo Coal assets: Kriel colliery, and the Elders, Zondagsfontein, New Largo and Heidelberg projects.

The Indonesian coal industry had serious problems due to prolonged heavy rain over many months, affecting mine output. In order to secure supplies, India's Tata Power agreed to pay US\$1.3 billion for a 30 per cent stake in two coal mines in Indonesia.

The new Prime Minister of Mongolia, Sanj Bayar, announced plans to take 100 per cent control of the US\$2 billion Tavan Tolgoi coal project. This project has estimated proven reserves of 6500 million tonnes of coal and is currently owned by Energy Resources LLC, a consortium of national mining companies.

There are numerous projects on clean coal and CO₂ capture that are in the research and developmental stages. In May, BP and Rio Tinto publicized the formation of a new jointly-owned company, Hydrogen Energy. This company will initially focus on hydrogen-fuelled power generation, using fossil fuels and

carbon capture and storage technology. Feasibility study plans were announced for the development of a US\$1.5 billion coal-fired power generation project at Kwinana, Western Australia. It will be fully integrated with carbon capture and storage, subject to regulatory approval.

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Production of coal

tonnes

Country	2002	2003	2004	2005	2006
Albania					
Lignite	15 000	18 000	20 000	19 000	...
Austria					
Brown coal & lignite (i)	1 411 824	1 152 389	235 397	13 931	7 854
Bosnia & Herzegovina					
Brown coal & lignite	9 000 000	9 342 222	8 896 257	9 144 850	9 965 053
Bulgaria					
Anthracite & bituminous	122 000	53 000	170 000	...	...
Brown coal & lignite	26 433 500	27 641 000	26 455 000	(i) 26 400 000	(i) 27 500 000
Czech Republic					
Bituminous	14 097 000	13 382 000	14 648 000	12 778 000	13 017 000
Lignite	501 000	470 000	450 000	467 000	459 000
Brown coal	48 834 000	49 920 000	47 840 000	48 658 000	48 915 000
France					
Anthracite & bituminous	1 483 000	1 728 000	200 000	—	—
Lignite	147 000	9 000	—	—	—
Georgia	6 100	7 900	8 100	5 100	8 284
Germany					
Anthracite & bituminous	26 363 084	25 873 043	25 871 882	24 909 867	20 882 119
Brown coal	181 778 432	179 086 923	181 926 060	177 907 945	176 324 117
Greece					
Lignite	71 087 609	69 410 756	71 237 228	71 700 000	71 500 000
Hungary					
Bituminous	660 000	667 126	280 000	—	—
Lignite	7 573 971	8 564 000	8 470 258	8 153 968	8 467 000
Brown coal	4 530 000	4 128 000	2 500 000	1 426 000	1 431 700
Italy					
Lignite	100 000	...	...	...	...
Macedonia					
Lignite	7 443 360	7 200 793	7 129 535	6 879 726	6 650 182
Montenegro					
Lignite	—	—	—	—	1 502 334
Norway					
Bituminous (d)	2 131 691	2 944 000	3 018 500	1 667 000	2 400 000
Poland					
Bituminous	103 546 000	103 016 400	100 087 100	97 903 730	95 222 512
Lignite	58 209 600	60 919 100	61 197 500	61 636 445	60 844 278
Romania					
Anthracite & bituminous	3 976 000	3 309 000	3 016 000	*3 000 000	*3 000 000
Brown coal & lignite	28 015 000	31 121 000	29 947 000	28 554 000	36 069 000
Russia	256 000 000	277 000 000	280 000 000	299 000 000	309 000 000
Serbia					
Bituminous	—	—	—	—	23 572
Brown coal & lignite	—	—	—	—	36 746 682
Serbia and Montenegro					
Bituminous	70 312	53 906	72 152	65 000	—
Lignite	32 936 248	34 542 677	35 267 074	35 853 000	—
Brown coal	422 661	377 187	352 474	363 000	—
Slovakia					
Brown coal	3 406 400	3 076 100	2 578 273	2 513 030	2 208 590
Slovenia					
Brown coal & lignite	4 684 710	4 828 786	4 807 302	4 539 556	4 520 754
Spain					
Anthracite	4 399 365	3 857 364	3 692 220	3 888 838	3 700 815
Bituminous	5 349 027	5 547 150	5 220 407	4 664 589	4 536 884
Sub-bituminous	3 537 710	3 182 572	3 426 001	3 354 014	3 101 930
Lignite	8 726 121	7 977 546	8 146 908	7 587 113	6 108 481
Turkey					
Anthracite	3 312 690	3 090 458	2 842 952	2 785 505	3 070 793
Bituminous	118 235	336 714	738 915	737 701	*740 000
Lignite	49 626 612	43 749 420	43 754 159	60 867 574	61 005 688
Ukraine					
Bituminous	81 650 000	78 700 000	79 629 000	78 425 000	80 300 000
Lignite	890 000	640 000	523 000	313 000	232 000
United Kingdom					
Bituminous (g)	29 989 000	28 279 000	25 096 000	20 498 000	18 528 000

Production of coal

tonnes

Country	2002	2003	2004	2005	2006
Botswana	953 081	822 780	913 087	984 876	962 427
Congo, Democratic Republic					
Bituminous	37 000	*35 000	*33 000	*31 000	*29 000
Egypt	*37 000	*35 000	*35 000	*35 000	*35 000
Malawi	43 372	47 037	40 891	44 900	48 000
Mozambique					
Bituminous	43 512	36 742	16 525	3 417	10 000
Niger	182 916	188 915	200 384	182 060	*180 000
Nigeria					
Sub-bituminous	10 000	*10 000	*10 000	*10 000	*10 000
South Africa					
Anthracite	1 304 965	1 206 105	1 486 619	1 639 414	1 584 424
Bituminous	218 900 000	236 670 504	241 884 911	242 724 560	243 197 975
Swaziland					
Bituminous	553 000	*550 000	488 314	221 701	*220 000
Tanzania					
Bituminous	79 210	54 610	65 041	30 795	17 940
Zambia					
Bituminous	*150 000	*150 000	*150 000	*150 000	*150 000
Zimbabwe					
Bituminous	3 938 175	2 824 362	3 797 669	2 890 662	2 107 115
Canada					
Bituminous	29 715 000	26 618 000	29 284 000	30 741 000	29 900 000
Sub-bituminous	25 528 000	24 880 000	25 147 000	25 742 000	26 100 000
Lignite	11 365 000	10 665 000	11 588 000	11 017 000	10 440 000
Mexico					
Bituminous	11 405 034	11 305 023	12 034 844	11 749 126	10 882 685
USA					
Anthracite (k)	1 240 000	1 169 000	1 542 000	1 542 000	*1 374 000
Bituminous (k)	519 012 000	491 240 000	509 384 000	518 193 000	*512 189 000
Sub-bituminous	397 674 000	401 520 000	422 204 000	430 648 000	*463 669 000
Lignite	74 807 000	78 380 000	75 750 000	76 113 000	*76 430 000
Argentina					
Bituminous	56 324	117 832	120 060	320 000	295 333
Brazil					
Bituminous & lignite (e)	5 143 488	4 643 319	5 408 278	6 048 105	6 215 258
Chile					
Bituminous	129 939	136 495	140 186	138 056	98 673
Lignite	321 687	210 783	98 121	594 309	575 071
Colombia					
Bituminous	39 484 000	50 028 000	53 691 000	59 064 000	65 596 000
Peru					
Anthracite & bituminous	21 579	17 104	57 759	29 535	107 091
Venezuela					
Bituminous	8 097 016	7 033 729	8 107 304	7 194 882	7 458 873
Afghanistan					
Bituminous	*2 000	*2 000	*2 000	*2 000	*2 000
Bangladesh (j)	...	22 322	64 605	87 143	303 016
Bhutan	88 567	66 324	29 631	85 279	*82 000
Burma (h)	115 175	109 214	237 949	229 647	*230 000
China					
Anthracite	250 000 000	218 000 000	220 000 000	*246 000 000	*267 000 000
Bituminous	1 110 000 000	1 470 000 000	1 690 000 000	*1 888 000 000	*2 052 000 000
Lignite	53 000 000	52 000 000	50 000 000	*56 000 000	*61 000 000
India					
Bituminous (h)	341 272 000	361 156 000	382 615 000	407 222 000	430 486 000
Lignite (h)	26 018 000	27 958 000	30 337 000	30 049 000	31 196 000
Indonesia					
Anthracite & bituminous	103 372 000	114 278 000	132 352 000	146 943 000	177 000 000
Iran					
Bituminous (c)	2 075 619	2 170 079	2 079 604	1 898 417	*2 000 000
Japan					
Bituminous	1 315 655	1 353 379	1 339 447	1 146 491	*1 100 000

Production of coal

tonnes

Country	2002	2003	2004	2005	2006
Kazakhstan					
Bituminous	70 735 300	80 497 400	82 929 900	81 869 200	(i) 96 300 000
Lignite	2 995 800	4 219 500	3 945 200	4 498 500	...
Korea, Dem. P.R. of					
Anthracite	17 000 000	16 000 000	16 300 000	16 500 000	16 000 000
Lignite	7 000 000	6 300 000	6 500 000	7 000 000	6 500 000
Korea, Republic of					
Anthracite	3 318 000	3 298 000	3 191 212	2 831 658	2 823 990
Kyrgyzstan	459 000	415 300	456 300	300 000	300 000
Laos	233 823	212 819	332 907	232 934	233 000
Malaysia	352 513	174 800	389 176	789 356	901 801
Mongolia					
Anthracite & bituminous	1 549 800	...	...	...	...
Brown coal & lignite	3 850 200	(i) 5 666 100	(i) 6 865 000	(i) 7 517 100	(i) 8 074 100
Nepal					
Sub-bituminous (b)	9 612	11 848	10 459	9 259	11 963
Pakistan (a) (j)	3 314 712	3 609 338	3 325 408	3 367 021	3 880 604
Philippines					
Bituminous	1 645 659	2 029 303	2 726 500	3 164 432	...
Tajikistan	23 600	46 500	92 200	98 500	102 300
Thailand					
Lignite	19 601 984	18 843 395	20 059 845	20 878 176	19 070 608
Uzbekistan					
Bituminous	80 000	61 600	*81 000	95 040	99 200
Lignite	2 660 000	1 850 000	*2 700 000	3 072 960	2 720 000
Vietnam					
Anthracite	16 409 100	19 314 000	27 349 000	34 396 000	38 900 000
Australia					
Bituminous (f)	272 560 000	280 700 000	294 810 000	308 000 000	316 000 000
Brown coal (j)	66 661 000	66 809 000	66 343 000	67 152 000	67 737 000
New Zealand					
Bituminous	2 268 906	2 351 021	2 526 613	2 543 404	2 863 029
Sub-bituminous	1 971 794	2 576 555	2 389 352	2 477 312	2 653 516
Lignite	218 239	252 336	239 429	246 445	251 366
World Total	4 815 000 000	5 208 000 000	5 546 000 000	5 879 000 000	6 189 000 000

Note(s):-

(1) There is no international agreement as to the separate definition of lignite and brown coal. In some cases they are distinguished. Elsewhere both may be aggregated under one or other term

- (a) Including lignite
- (b) Years ended 15 July of that shown
- (c) Years ended 20 March following that stated
- (d) Spitzbergen: not including production from mines controlled by the former Soviet Union
- (e) Including beneficiated and directly shipped material
- (f) Including sub-bituminous
- (g) Including anthracite
- (h) Years ended 31 March following that stated
- (i) Coal; all forms
- (j) Years ended 30 June of that stated
- (k) Includes a small amount of refuse recovery

Mine production of cobalt

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Russia	*4 200	4 654	4 527	4 748	4 759
Botswana	269	294	223	326	303
Congo, Democratic Republic	*14 500	*14 500	*20 500	*22 000	*22 000
Morocco	1 335	1 391	*1 600	*1 600	1 400
South Africa	366	271	309	268	267
Zambia	6 144	6 620	5 791	5 472	4 556
Zimbabwe	74	44	59	275	290
Canada	5 148	4 327	5 060	5 767	6 976
Cuba	3 856	3 643	3 979	*4 000	*4 000
Brazil	4 300	4 200	4 300	*4 300	*4 300
China	1 004	707	1 253	2 104	*2 100
Indonesia	*650	*650	*650	*650	*650
Australia (a)	2 763	2 562	2 004	5 198	*5 700
New Caledonia	2 780	2 602	2 726	1 769	1 629
World Total	47 000	46 000	53 000	58 000	59 000

Note(s):-

- (1) There is frequently a considerable disparity between the cobalt content of ore raised and cobalt actually recovered
(2) Figures in this table relate where possible to cobalt recovered. The principal exceptions to this are Brazil and New Caledonia, the figures for which relate to cobalt in ore raised

(a) Years ended 30 June of that stated

Production of cobalt metal

tonnes

Country	2002	2003	2004	2005	2006
Belgium	1 135	1 704	(d) 2 947	(d) 3 298	(d) 2 840
Finland	8 240	7 989	7 893	8 171	8 582
Norway	4 000	4 556	4 670	5 021	4 900
Russia	4 200	4 654	4 524	4 748	4 759
Congo, Democratic Republic (c)	2 149	1 200	735	600	550
Morocco	1 354	1 341	1 593	1 613	1 405
South Africa (b)	366	271	329	268	267
Uganda	*450	—	459	638	689
Zambia	6 144	6 620	5 791	5 422	4 556
Canada (a)	4 625	4 233	5 144	5 090	5 180
Brazil	960	1 097	1 155	1 136	902
China	1 842	4 576	(d) *8 000	(d) *12 700	(d) *12 700
India	270	255	545	1 220	1 184
Japan	354	379	421	471	920
Australia	3 701	3 839	3 879	3 150	3 996
World Total	39 800	42 700	48 100	53 500	53 400

Note(s):-

- (1) In addition to the production listed above, several countries, including the United Kingdom, Finland and France, are known to produce substantial amounts of cobalt compounds

(a) Including oxides

(b) Includes metal and metal contained in sulphate

(c) Excludes white alloy and matte which are believed to be further processed in Belgium and elsewhere

(d) Some metal production in China is recorded in Belgium

COPPER

Characteristics

Copper is a reddish, malleable and ductile metal valued for its excellent thermal and electrical conductive properties and its resistance to corrosion. Copper combines with a number of elements to form a wide variety of copper minerals and ores. More than 150 copper-bearing minerals have been identified although only a small number of these, chief of which is chalcopyrite (CuFeS_2), are of economic importance. The upper parts of orebodies often also contain 'oxide' ore minerals such as malachite and chrysocolla. These are underlain by a layer of 'sulphide enrichment' characterised by the sulphide mineral, chalcocite. Types of copper orebody include: 'porphyries', typical of North and South America, where disseminated copper minerals are associated with igneous intrusions; stratabound orebodies where the copper occurs in sedimentary rocks; and volcanic-hosted massive sulphide (VMS) deposits, in which copper is associated with other base metal sulphides such as lead and zinc. The largest reserves are in Chile (150 million tonnes), Indonesia and USA (35 million tonnes each), Mexico, Peru and Poland (30 million tonnes each); (Edelstein 2008).

Uses

The ability to conduct electricity and heat are two of the most important properties of copper, since about 40 per cent (in Europe) of all copper produced is used in electrical and electronic applications (International Copper Study Group, 2007). When alloyed with other metals it acquires additional properties including: increased hardness, tensile strength, and improved corrosion resistance. Brass and bronze are two of the most important alloys of copper. Coppers malleability and ease of use in machines during the fabrication process allows for a high production rate of accurate copper shapes for a relatively lower cost than that of its substitutes. Copper is a major industrial metal, due to its beneficial properties discussed here, ranking third after iron and aluminium in terms of quantity consumed.

Statistics for the final applications of copper products vary widely: in the USA the dominant sector is 'construction' (50 per cent), in Europe it is 'transport' (41 per cent) and in Asia 'electrical' (33 per cent) (International Copper Study Group, 2007). These differences are at least partly caused by differing statistical methodologies. The chief immediate use of copper is in electrical circuits, wiring and cables, regardless of the final application. Copper is used in many forms in buildings including wire, plumbing pipes and fittings, electrical outlets, switches, and locks. Construction of an average modern house requires at least 200 kg of copper metal. Copper roofing is highly rated for its corrosion resistance and architectural characteristics. Copper is the best electrical conductor after silver and is widely used in the production of energy-efficient power circuits. Copper wire is extensively used in telecommunications and is essential for computer networks.

World production in 2006

Copper is produced in about fifty countries. Eight countries account for about 80 per cent of world mine production. Each of these eight countries produce over 500 000 tonnes of copper per year.

In the last 20 years, copper production has almost doubled from 8.4 million tonnes in 1985 to more than 15 million tonnes in 2006. This sustained rise can be attributed to the steady increase in copper demand from growing economies around the world. The proportion of copper mined in South

America has increased from about one-quarter to nearly one-half of total world production. This is largely due to an increase in production from Chile, from 16 per cent of world production in 1985 to 35 per cent in 2006. Total production from North and Central America has not increased significantly, despite a 55 per cent rise in Mexican output. The contribution from Asia has been increasing and Africa's copper production has also risen in recent years driven by Zambia and the Democratic Republic of Congo (DRC). Zambia's mine production has increased by 63 per cent from 307 834 tonnes in 2002 to 502 000 tonnes in 2006. The DRC copper production has risen rapidly during the last five years as stability returns to the country, following five years of war. DRC, which has the potential to become an extremely significant copper producer, increased copper production from 28 000 tonnes in 2002 to 131 400 tonnes in 2006.

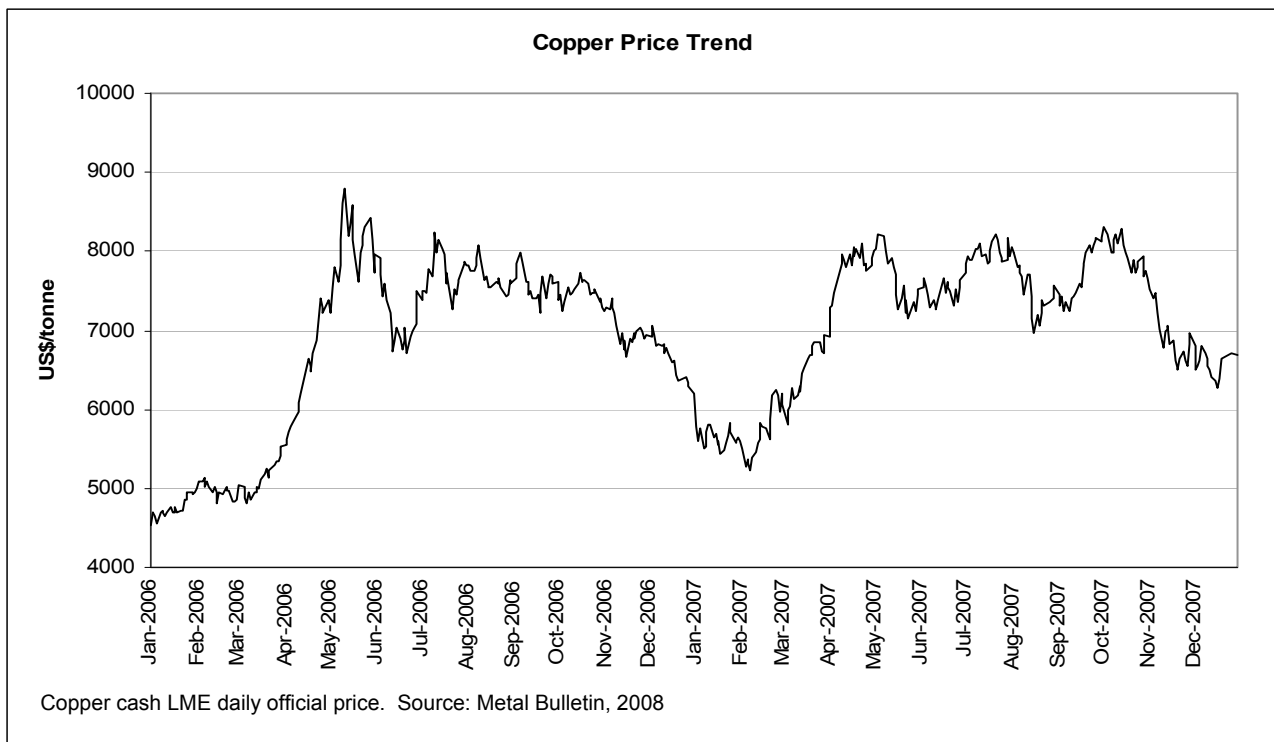
Rising demand for copper has meant that many mines are now operating at almost full capacity. Smelter and refinery capacities are becoming a bottleneck to production. This coupled with limited expansion potential and diminishing ore reserves of existing mines, means that production is likely to level off unless the current high copper prices are reinvested into exploration and future production infrastructure. Copper mine production depends on a relatively small number of large production units. It is therefore vulnerable to disruptions caused by strikes, natural disasters and concerns over supplies of natural gas and water. Improved mining and extraction techniques now allow copper from low grade ores, that were previously considered as waste, to be extracted using chemical and bio-leaching techniques. However, in many cases the leach cycle may be measured in years, resulting in a considerable lag time in copper metal production by these methods.

Total world copper mine production in 2006 was 15 million tonnes. Chile is the largest copper-producing country, with an output of 5.4 million tonnes in 2006. Total world production of smelter copper was 11.8 million tonnes in 2006, with Asia contributing 44 per cent of the world total. During the last 10–15 years mine production statistics have become decoupled from total smelter production, whereas prior to 1990 the two correlated very well. This statistical divergence is explained by the increasing use of chemical extraction techniques which compete with conventional smelter production. Total world refined copper production was 17.2 million tonnes in 2006, from over 45 countries. The difference between mine and refinery production is attributed to the contribution of secondary refined (scrap) copper to the total. Recycling of old scrap provides about 20 per cent of annual copper consumption.

Prices

The price paid for copper on the metal exchanges primarily reflects global balances of copper supply and demand, but may be significantly affected by speculative activity, currency exchange rates and market news. Copper demand and price typically reflect global economic cycles, and as a result the copper price has historically experienced major fluctuations. All copper prices quoted are based on the London Metal Exchange (LME) cash daily official price, in US dollars per tonne, as quoted by Metal Bulletin.

The copper market was exceptionally strong during 2006 with copper prices averaging US\$6700 tonne over the whole year, an 83 per cent increase over 2005. During the first five months of 2006, copper prices continued their upward trend and in



May the London Metal Exchange (LME) spot price reached a record-high of US\$8780 tonne, with an average monthly price of US\$8044 tonne. The deficit in the availability of refined copper experienced during the previous three years persisted into 2006. This resulted in tight supply and critically low exchange levels, amounting to less than three days global consumption at times. The supply – demand imbalance ensured prices reacted strongly to market developments resulting in considerable volatility and price spikes. Higher metal prices resulted in increased speculative demand for copper as an investment. Global mine production in 2006 was lower than expected as a result of production problems and labour disputes in key copper-producing countries. By the end of 2006, copper prices had fallen considerably from the record highs in May of that year. This reflected moderation in demand largely resulting from consumers drawing on their own stocks, recovery of global mine output from disruptions earlier in the year, and growing exchange inventories.

The downward price trend in the second half of 2006 continued into 2007 with prices falling below US\$5500 tonne in early February. This resulted from uncertainty in the US construction market and a failure of Chinese refined copper imports to return to expected levels. Prices subsequently began to rise as LME inventories declined due to increasing Chinese imports of refined copper. Prices rose strongly during March and April 2007 in response to increasing Chinese demand. Prices remained high in the first half of May due to strikes in Peru and flooding in Argentina, reducing shipments and lowering inventories. Prices became more volatile in the second half of May in response to labour disputes, apparently adequate Chinese inventories and news relating to US interest rates. Labour conflicts maintained prices during early August, followed by a considerable downturn in mid-August in response to financial uncertainty associated with the US subprime mortgage crisis. Prices recovered as central banks intervened to help the global financial system and labour problems in Peru pushed copper to its highest annual price of US\$8300 tonne in October 2007. In mid-October prices began to fall reaching a low of US\$6270 tonne in December as concerns over the global economic outlook resurfaced, which led to uncertainty in copper demand from industrialised

countries. News of declining copper imports into China during October also influenced the copper price during this period (Hinde, 2007). Despite this, the average annual price of copper on the LME was 5.9 per cent higher in 2007 than in 2006, at US\$7100 tonne.

Industry events in 2007

Following on from 2006, strikes and industrial disputes continued to affect copper production in 2007. In April production at the Grasberg copper-gold deposit, one of the world's largest copper mines, was halted by workers striking over pay conditions (Mortished, 2007). Grupo Mexico, the world's fourth largest copper producer was strongly affected by strike action during 2007. A four-month strike at the company's Cananea mine reduced Grupo Mexico's annual production for 2007 by around 10 per cent (Daniel and Rosenberg, 2007). Nationwide strikes occurred in Peru during November over labour laws; affecting production at a number of mines including Antamina, Peru's largest copper mine (Montia, 2007).

An abundance of new projects and mine expansions were planned or commissioned during 2007. Notable expansions include that at Freeport-McMoran's Cerro Verde mine in Peru, which reached design capacity in mid-June and is expected to produce around 300 000 tonnes of copper annually (Freeport-McMoRan, 2007). BHP Billiton announced that it would restart production at its mothballed Pinto Valley copper mine in Arizona, which will produce around 70 000 tonnes of copper in concentrate annually (Reuters, 2007). Grupo Mexico has plans to invest US\$4 billion during the next five years in its Mexican operations, with the aim of doubling copper production (Mining Journal, 2007). Expansions continued at operations on the Zambian Copperbelt during 2007, driven by buoyant copper prices and sustained Chinese investment interest (Mining Weekly, 2007). BHP Billiton has announced an increase of 77 per cent by tonnage and 38 per cent by contained copper in the total resource estimate for its Olympic Dam mine, in Australia and a US\$6 billion expansion is planned (BHP Billiton, 2007a; Mercer, 2007). Copper refining capacity increased during 2007, led by China which has commissioned extensive new capacity in recent years (Penney,

2007). During March BHP Billiton officially opened its Spence mine in Chile, capable of producing 200 000 tonnes of refined copper cathode annually (BHP Billiton, 2007b).

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Mine production of copper

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Albania	—	—	642	1 696	400
Armenia	16 641	18 068	17 700	16 400	17 800
Bulgaria	84 400	91 600	79 600	82 700	99 000
Cyprus	3 700	2 500	—	—	900
Finland	14 400	14 900	15 500	15 000	13 000
Georgia	*13 000	14 700	*12 000	*6 000	14 600
Macedonia	4 739	618	—	4 799	7 054
Poland	502 800	503 544	530 768	511 799	497 200
Portugal	77 227	77 581	95 700	89 541	78 660
Romania	19 323	23 389	20 380	16 286	12 179
Russia	662 100	630 000	630 000	660 000	675 000
Serbia	—	—	—	—	11 100
Serbia and Montenegro	23 100	15 500	13 800	11 600	—
Spain	1 248	635	1 308	7 358	8 700
Sweden	71 991	83 143	82 415	87 068	86 746
Turkey	48 217	43 245	38 876	30 067	*30 000
Botswana	21 590	24 289	21 195	26 704	24 255
Congo, Democratic Republic	28 000	56 900	69 600	98 000	131 400
Mauritania	...	...	...	...	5 031
Morocco	4 994	4 818	4 400	*4 000	4 500
Namibia	18 040	16 175	11 174	10 157	6 262
South Africa	90 000	89 338	85 710	85 000	89 700
Tanzania	4 200	3 715	4 240	3 661	3 285
Zambia	307 834	346 900	412 300	441 100	502 000
Zimbabwe	1 356	1 374	2 383	2 570	2 581
Canada	603 498	557 082	562 795	595 383	606 958
Mexico	329 574	355 653	405 539	429 042	429 042
USA	1 142 400	1 116 000	1 160 000	1 140 000	*1 220 000
Argentina	204 027	199 020	177 143	187 317	180 144
Brazil	32 711	26 275	103 153	133 325	147 836
Chile	4 580 600	4 904 200	5 412 500	5 320 500	5 360 800
Colombia	1 700	1 500	1 600	1 800	600
Peru	842 783	842 578	1 035 574	1 009 898	1 049 933
Burma	27 500	27 900	31 800	34 500	19 500
China	578 100	614 400	742 200	776 000	*915 000
India (a)	32 780	29 529	30 072	24 964	*31 000
Indonesia	1 171 726	1 005 837	840 318	1 063 849	817 796
Iran	140 700	146 100	153 000	149 900	*150 000
Japan	1 519	1 000	1 000	*1 000	*1 000
Kazakhstan	473 700	484 500	461 800	401 700	459 200
Korea, Dem. P.R. of	*12 000	*12 000	*12 000	*12 000	*12 000
Laos	—	—	1 700	30 480	60 803
Mongolia	131 700	130 300	129 990	126 560	129 675
Pakistan	—	5 400	14 700	17 700	18 700
Philippines	18 365	20 414	15 984	16 320	17 700
Saudi Arabia	600	800	652	668	604
Uzbekistan	*80 000	*80 000	83 000	103 500	103 500
Vietnam	1 100	1 200	2 000	3 100	11 400
Australia	879 000	830 000	854 000	935 000	875 000
Papua New Guinea	211 315	202 300	173 370	192 978	194 355
World Total	13 500 000	13 700 000	14 600 000	14 900 000	15 100 000

Note(s):-

(a) Years ended 31 March following that stated

Smelter production of copper

tonnes

Country	2002	2003	2004	2005	2006
Armenia	6 502	6 259	9 470	9 881	8 791
Bulgaria	167 000	199 300	215 800	225 000	217 000
Finland	160 896	160 596	151 647	157 900	164 300
Germany	295 100	288 800	278 600	257 200	273 800
Norway	30 483	35 851	35 643	38 681	39 700
Poland	510 725	559 960	547 228	555 681	555 907
Romania	3 000	3 000	61	—	—
Russia	660 300	662 000	661 900	695 500	712 300
Serbia	—	—	—	—	28 900
Serbia and Montenegro	36 100	10 500	5 500	16 300	—
Spain	298 057	290 282	224 249	284 215	263 662
Sweden	186 984	175 475	174 459	153 399	194 194
Turkey	19 375	18 400	34 700	27 700	26 300
Congo, Democratic Republic (a)	1 800	3 000	2 000	4 300	3 200
Namibia	26 670	26 306	24 704	21 699	21 918
South Africa	117 000	112 000	89 300	105 500	100 400
Zambia (a)	245 000	245 000	280 100	244 800	289 700
Canada	513 934	430 116	446 209	441 325	484 675
Mexico	284 220	260 754	298 702	340 462	298 526
USA	683 300	538 700	542 100	523 000	501 000
Brazil	187 605	173 378	208 020	199 043	219 684
Chile	1 438 700	1 542 400	1 517 600	1 558 100	1 565 400
Peru	380 834	314 228	320 135	321 968	322 188
China	1 179 900	1 379 200	1 502 900	1 751 500	1 850 000
India (c)	195 025	205 187	189 965	310 694	*273 000
Indonesia	211 200	247 400	211 600	275 000	201 200
Iran (b)	143 439	145 670	152 463	*200 000	*200 000
Japan	1 283 173	1 278 380	1 220 448	1 266 432	1 361 771
Kazakhstan	446 198	431 930	444 537	404 817	426 000
Korea, Dem. P.R. of	*10 000	*10 000	*10 000	*10 000	*10 000
Korea, Republic of	380 000	410 000	392 500	436 600	449 200
Oman	*25 000	17 000	17 100	24 500	20 700
Pakistan	—	4 900	13 000	18 600	23 600
Philippines	165 800	227 900	217 300	201 300	239 600
Thailand	—	—	17 700	28 600	1 000
Uzbekistan	77 000	77 000	103 400	115 000	120 000
Vietnam	—	—	—	—	4 800
Australia	458 000	435 000	443 000	410 000	377 000
World Total	10 800 000	10 900 000	11 000 000	11 600 000	11 800 000

Note(s):-

(1) This table shows primary metal in the form of blister and anode produced from concentrates, and may include copper produced from scrap but this is excluded when it can be separately identified

(a) Including leach cathodes

(b) Years ended 20 March following that stated

(c) Years ended 31 March following that stated

Production of refined copper

tonnes

Country	2002	2003	2004	2005	2006
Austria	64 900	65 100	74 200	72 300	72 600
Belgium	422 500	423 000	383 000	382 900	378 600
Bulgaria	40 700	45 900	55 300	60 100	65 500
Cyprus	3 695	2 552	1 344	—	880
Finland	126 016	135 713	132 384	132 126	137 961
Germany	695 741	597 531	652 600	638 800	662 300
Italy	32 400	26 700	33 600	32 200	36 400
Norway	30 600	35 852	35 643	38 681	39 700
Poland	508 674	529 616	550 066	560 256	556 625
Romania	11 453	16 739	24 526	20 739	21 581
Russia	855 100	842 000	919 000	934 900	943 200
Serbia	—	—	—	—	41 400
Serbia and Montenegro	35 897	14 029	11 998	31 300	—
Slovakia	6 989	600	—	—	—
Spain	312 145	293 495	228 466	313 105	299 146
Sweden	224 402	214 181	235 620	223 482	229 241
Turkey	41 000	36 900	63 000	95 000	105 800
Ukraine	2 500	16 800	5 500	13 600	17 300
Congo, Democratic Republic	—	—	200	2 500	3 200
Egypt	...	...	14 119	18 469	*18 000
South Africa	99 100	93 300	87 300	98 600	100 300
Zambia	347 235	360 100	407 900	445 600	497 200
Zimbabwe	5 400	5 000	5 800	6 000	6 700
Canada	494 522	454 866	526 955	515 223	500 463
Mexico	319 200	295 800	333 700	377 500	303 626
USA	1 511 900	1 306 300	1 310 800	1 255 800	*1 250 000
Argentina	*16 000	*16 000	*16 000	*16 000	*16 000
Brazil	187 605	173 378	208 020	199 043	219 684
Chile	2 850 100	2 901 900	2 836 700	2 824 000	2 811 300
Peru	502 749	517 046	505 306	510 392	507 710
Burma	27 500	27 900	31 800	34 500	19 500
China	1 632 500	1 836 300	2 198 700	2 600 400	2 998 900
India (b)	378 850	395 967	413 354	529 248	*509 000
Indonesia	192 400	223 300	210 500	262 900	217 600
Iran (a)	171 592	168 613	182 814	*180 000	*201 000
Japan	1 401 079	1 430 365	1 380 144	1 395 284	1 532 055
Kazakhstan	452 989	432 401	445 792	418 865	429 700
Korea, Dem. P.R. of	*15 000	*15 000	*15 000	*15 000	*15 000
Korea, Republic of	499 116	509 970	495 952	526 563	575 492
Laos	—	—	—	30 500	60 800
Mongolia	1 500	1 341	2 376	2 475	2 600
Oman	23 975	17 040	15 090	24 500	20 700
Philippines	144 300	171 200	174 600	172 000	181 000
Thailand	—	—	20 000	26 100	27 050
Uzbekistan	77 100	77 000	85 000	115 000	115 000
Vietnam	—	—	—	—	4 800
Australia	542 000	484 000	498 000	469 000	429 000
World Total	15 300 000	15 200 000	15 800 000	16 600 000	17 200 000

Note(s):-

- (1) Figures relate to both primary and secondary refined copper, whether electrolytic or fire refined. Metal recovered from secondary materials by remelting alone is excluded
- (2) In addition to the countries listed, Albania and Colombia produce refined copper

- (a) Years ended 20 March following that stated
- (b) Years ended 31 March following that stated

Production of diamond

carats

Country	2002	2003	2004	2005	2006
Russia	*20 000 000	33 020 000	38 865 770	38 000 990	38 360 810
Angola	*5 700 000	*6 300 000	6 146 361	7 079 121	9 175 061
Botswana	28 368 000	30 412 155	31 125 000	31 889 771	34 293 401
Cameroon (b)	5 000	5 500	12 000	*12 000	*12 000
Central African Republic	414 767	331 543	354 703	382 756	419 528
Congo, Democratic Republic	21 985 000	29 000 000	30 040 479	33 054 998	28 990 241
Ghana	963 493	904 089	905 344	1 065 923	972 991
Guinea	491 160	666 000	739 784	548 522	473 862
Ivory Coast	306 000	230 000	*300 000	*300 000	*300 000
Lesotho	721	1 899	26 607	52 036	112 408
Liberia	80 000	60 000	30 000	*30 000	*30 000
Namibia	1 537 505	1 454 756	2 003 868	1 902 484	2 356 285
Sierra Leone	351 859	506 819	693 104	668 807	582 324
South Africa	10 882 614	12 673 379	14 294 662	15 775 720	15 152 801
Tanzania	239 761	236 382	303 920	219 640	272 204
Togo	...	87 200	123 106	17 670	28 176
Zimbabwe	—	—	44 454	243 928	1 046 025
Canada	4 975 021	10 755 654	12 618 080	12 314 000	13 234 813
Brazil	*500 000	*400 000	*300 000	*300 000	*200 000
Guyana	248 437	412 538	454 940	356 948	343 544
Venezuela	141 463	38 489	40 036	55 154	16 981
China	1 190 000	1 190 000	*1 060 000	*1 060 000	*1 065 000
India (a)	84 407	71 259	78 315	44 171	2 179
Indonesia	*30 000	*30 000	*30 000	21 606	46 856
Australia	33 648 000	31 013 000	20 620 000	30 678 000	29 308 000
World Total	132 100 000	159 800 000	161 200 000	176 000 000	176 800 000

Note(s):-

- (1) This table does not show production of synthetic diamond
- (2) So far as possible the amounts shown include estimates for illegal production

- (a) Years ended 31 March following that stated
- (b) Including artisanal production

Production of diatomite

tonnes

Country	2002	2003	2004	2005	2006
Commonwealth of Independent States (f)	*80 000	*80 000	*80 000	*80 000	*80 000
Czech Republic	5 600	4 800	3 800	4 100	4 827
Denmark					
Moler (d)	211 000	221 000	188 000	209 000	196 000
France	*80 000	*80 000	*75 000	*75 000	*75 000
Hungary	1 656	1 770	1 640	2 190	495
Iceland	26 494	27 693	20 625	—	—
Poland	1 000	700	800	1 700	*1 700
Romania	20 922	33 296	20 626	1 402	—
Spain (b)	53 558	57 934	33 799	44 335	40 000
Algeria	3 185	2 335	2 665	1 814	1 800
Ethiopia	...	...	2 000	420	—
Kenya	1 333	353	330	243	185
Costa Rica	*26 400	26 450	*27 000	27 000	26 000
Mexico	62 322	53 395	59 818	62 132	62 948
USA (c)	624 000	599 000	620 000	653 000	*655 000
Argentina	23 314	35 518	8 180	34 045	38 543
Brazil	5 835	6 920	7 200	7 670	8 968
Chile	30 274	25 594	30 015	27 091	28 900
Colombia	*4 000	*4 000	*4 000	*4 000	*4 000
Peru	*35 000	*35 000	*35 000	*35 000	*35 000
China	*370 000	*380 000	370 000	400 000	*420 000
Iran (a)	300	1 000	1 000	1 450	*1 500
Japan	123 827	111 690	126 255	*100 000	*100 000
Korea, Republic of	20 666	15 636	2 441	2 193	3 460
Saudi Arabia	1 000	1 000	*1 000	*1 000	*1 000
Thailand	780	1 288	1 372	990	1 344
Vietnam	*10 000	*10 000	*10 000	*10 000	*10 000
Australia (e)	31 122	31 758	34 571	*36 000	*35 000
World Total	1 854 000	1 848 000	1 767 000	1 820 000	1 830 000

Note(s):-

(1) In addition to the countries listed, Egypt and Turkey are believed to produce diatomite

(a) Years ended 20 March following that stated

(b) Including tripoli

(c) Sold or used by producers

(d) Moler is an impure diatomite containing a large proportion of clay

(e) Years ended 30 June of that stated

(f) Diatomite is produced in Armenia, Georgia and Russia but information is not available to provide estimates for individual countries

Production of feldspar

tonnes

Country	2002	2003	2004	2005	2006
Bulgaria	*34 000	*35 000	*35 000	*35 000	*35 000
Czech Republic	401 000	421 000	488 000	472 000	487 000
Finland	39 552	59 362	44 495	42 783	43 187
France	659 000	654 000	628 000	651 000	*650 000
Germany	243 368	233 028	182 842	168 640	167 332
Greece	124 100	102 800	88 274	100 586	*100 000
Italy	*2 500 000	*2 200 000	2 201 258	1 801 846	*1 800 000
Macedonia	22 800	25 640	22 921	27 076	38 124
Norway	75 184	70 000	67 000	*67 000	*67 000
Poland	209 226	276 264	373 459	426 914	359 512
Portugal	141 125	129 366	98 262	133 344	129 333
Romania	51 959	72 827	60 924	74 927	37 553
Russia	90 533	121 405	156 391	*160 000	*160 000
Serbia and Montenegro	7 813	3 045	180	...	...
Spain	548 964	563 580	552 507	650 061	670 000
Sweden	37 000	44 000	38 000	30 000	24 000
Turkey	1 766 387	1 862 310	1 983 336	2 331 971	*2 500 000
Ukraine	...	...	48 800	63 930	67 312
United Kingdom (c)	1 896	1 309	2 274	1 835	1 441
Algeria	...	...	...	43 872	65 615
Egypt (d)	*350 000	*350 000	*350 000	*350 000	*350 000
Morocco	19 402	*20 000	*20 000	*20 000	*20 000
South Africa	66 616	57 738	53 721	56 574	76 722
Zimbabwe	824	816	79	—	—
Cuba	*7 000	*7 000	10 515	8 020	5 500
Guatemala	13 044	9 320	4 473	3 808	17 176
Mexico	332 101	346 315	364 166	373 411	459 209
USA	790 000	800 000	770 000	750 000	*760 000
Argentina	82 642	90 857	125 684	151 307	170 728
Brazil	97 742	102 077	280 293	196 419	166 418
Chile	3 069	6 690	4 838	5 820	8 547
Colombia	93 450	*100 000	*100 000	*100 000	*100 000
Ecuador	31 254	44 268	53 469	38 250	*40 000
Peru	6 018	7 349	6 005	9 038	9 287
Uruguay	1 550	2 450	1 950	2 150	2 470
Venezuela	146 619	149 450	175 864	202 000	*200 000
Burma	*10 000	*10 000	*10 000	*10 000	*10 000
China	*2 000 000	*2 000 000	2 300 000	2 300 000	*2 300 000
India (a)	239 093	332 220	379 055	322 929	362 853
Indonesia	*24 000	*24 000	*24 000	*24 000	*24 000
Iran (b)	228 848	293 370	248 710	286 033	*280 000
Japan (e)	1 143 618	1 006 093	*889 000	*800 000	*800 000
Jordan	530	13 057	13 063	1 000	11 054
Korea, Republic of	519 125	477 012	541 788	508 644	427 378
Malaysia	30 819	42 662	79 220	117 180	142 358
Pakistan (d)	35 071	37 344	30 373	25 032	22 435
Philippines	32 874	34 546	32 106	11 853	*12 000
Saudi Arabia	30 470	33 700	37 400	42 587	46 700
Sri Lanka	28 866	32 586	38 600	45 492	56 050
Taiwan	—	510	900	—	—
Thailand	783 733	824 990	1 001 053	1 149 717	1 067 684
Uzbekistan	*4 300	*4 300	*4 300	*4 300	*4 300
Vietnam	*120 000	*150 000	*180 000	*200 000	*200 000
Australia (d)	100 560	118 115	108 073	*97 000	*102 000
World Total	14 400 000	14 500 000	15 400 000	15 500 000	15 700 000

Note(s):-

(1) In addition to the countries listed, Slovakia is believed to produce feldspar

(a) Years ended 31 March following that stated

(b) Years ended 20 March following that stated

(c) China stone

(d) Years ended 30 June of that stated

(e) Including weathered granite feldspar

FLUORSPAR

Characteristics

Fluorspar is the commercial name for the mineral fluorite (calcium fluoride, CaF_2). The pure form consists of 51.1 per cent calcium and 48.9 per cent fluorine. Fluorine represents an average 0.06 to 0.09 per cent of the Earth's crust and is mainly found occurring in fluorite. It is also found in small amounts in a wide variety of other minerals, such as apatite and phlogopite. Fluorite generally occurs as well-formed cubic crystals exhibiting a wide range of colours and usually contains mineral impurities such as calcite, quartz, barytes, celestite, various sulphides or phosphates. Commercial fluorspar is graded according to quality and specification into acid-grade (minimum 97 per cent CaF_2), metallurgical grade (minimum 80 per cent CaF_2) and ceramic grade (80 – 96 per cent CaF_2 and up to three per cent SiO_2).

Fluorspar is found in a wide range of geological environments on every continent. The primary economic source of fluorspar is in vein deposits (sheet-like bodies formed by minerals crystallising from aqueous solutions to fill fissures in rock) where it occurs as the main mineral or with metallic ores, in particular lead, zinc, silver and barytes. It also occurs as replacement deposits, replacing limestone or marble. In vein deposits fluorspar tends to occur as lenticular bodies, separated by barren areas. The mineralised veins vary considerably in width and length, usually being between 1 m to 10 m wide and 50 m to 500 m long.

World reserves of fluorspar (measured as pure CaF_2) are 240 million tonnes (Mt), of which South Africa holds 41 Mt, Mexico 32 Mt and China 21Mt (USGS, 2008).

The grade of fluorspar determines its end-use. Approximately 34 per cent of fluorspar produced worldwide is of metallurgical grade and is used primarily as a flux in steelmaking and in the production of aluminum. Ceramic grade fluorspar is used in the production of glass and ceramics as well as the manufacture of magnesium and calcium metal and accounts for a very limited amount of worldwide production. Around 65 per cent of fluorspar produced is acid-grade fluorspar; this is used in the production of hydrofluoric acid (HF), the basis for all fluorine-bearing compounds, which include important pharmaceuticals and agrochemicals. One of the largest uses of hydrofluoric acid was in the production of chlorofluorocarbons (CFCs) but CFC production in recent years has rapidly declined due to concern over the effect of the chlorine component in depleting the ozone. To some extent they have been replaced by hydrofluorocarbons (HFCs) although these are classed as 'greenhouse gases' and their use is strictly controlled. Acid grade fluorspar is also an important component in plastics manufacture. Fluoropolymers such as Teflon® have high thermal stability, high chemical inertness, strong electrical insulation and a low coefficient of friction and so have many applications. A rapidly growing market is nitrogen trifluoride (NF_3) which is widely used as a cleaning gas in the manufacture of semiconductors and LCD screens.

World production in 2006

World production in 2006 increased by eight per cent: a small decrease from the nine per cent rise seen in 2005. There has been steady growth in fluorspar production since 2003, driven for the most part by increased Chinese consumption. China also continued its dominance of world fluorspar production with 54 per cent of the total. Chinese production increased by 11 per cent from 2005–2006 and has increased by 13 per cent in the last five years. The world's second largest producer,

Mexico, showed a production increase of seven per cent in 2006 and production has risen by 50 per cent since 2002. The figures from the world's third largest producer, South Africa, were not so positive with a 10 per cent drop in production. This was due to the country's largest producer, Sallies, experiencing delays on planning decisions for new mining infrastructure, low recovery grades, equipment breakdowns and heavy rains.

European production was stable, with the largest producers Russia and Spain showing little or no change. French production dropped by 25 per cent following the closure of three mines in the Pyrenees due to depletion of reserves. Italy's sole fluorspar producer, Nuova Mineraria Silius, ceased operations due to the end of government subsidies.

Prices

Over the last twelve months fluorspar prices have been stable with only small increases in prices for certain grades. However the average price in 2007 was 30 per cent more than the average in 2006, continuing a steady pattern of growth since 2003. Mexican acidspare filtercake (f.o.b. Tampico), was priced at US\$180 – US\$200 per tonne and Chinese acidspare filtercake (c.i.f. US Gulf Port) was priced at US\$305 and US\$310 per tonne in 2007. Higher Chinese prices were caused in part by the raising of their export tax from 10 per cent to 15 per cent on 1 June.

Industry events in 2007

China continued a pattern of decreasing fluorspar exports in 2007, dropping the export quota by four per cent (USGS, 2008). This caused a shortfall of fluorspar in the world market and pushed prices up. Several major fluorspar deposits continued to undergo development in 2007. Minemakers of Australia continued to develop the Moina skarn in Tasmania, Australia's largest fluorspar deposit, with an interim resources estimate scheduled to be completed in 2008.

In South Africa, 2007 was a more positive year for Sallies, owner of the Witkop mine, production increased with the development of the Buffalo tailings operation and the company is once again reported to be making a profit. Central African Mining and Exploration Company (CAMEC) began a feasibility study on the Doornhoek deposit, potentially the world's largest deposit.

In the UK Glebe Mines was taken over by Ineos Fluor. This move should secure Ineos Fluor's fluorspar supplies for hydrofluoric acid (HF) manufacture and secure the UK's fluorspar and HF industries for the near future.

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Production of fluorspar

tonnes

Country	2002	2003	2004	2005	2006
France	122 000	90 000	70 000	53 000	*40 000
Germany	34 429	33 289	33 203	35 364	53 009
Italy	53 260	26 387	24 339	70 326	...
Romania	*15 000	*15 000	*15 000	*15 000	*15 000
Russia	*169 000	*170 000	*200 000	*210 000	*210 000
Spain	141 434	139 266	145 694	144 126	146 946
Turkey	718	718	880	800	*800
United Kingdom	*53 000	*56 000	50 080	60 980	*60 000
Egypt	502	*500	*500	7 746	*7 700
Kenya (d)	85 015	80 201	117 986	109 594	132 030
Morocco	94 910	81 225	*81 000	*95 000	*115 000
Namibia	81 084	79 281	104 785	114 886	132 249
South Africa	227 000	235 000	264 900	265 600	*240 000
Mexico	622 477	756 258	842 698	875 450	936 433
Argentina	5 168	5 422	6 189	7 502	8 278
Brazil (a)	47 899	56 346	57 772	66 512	63 604
China	2 650 000	2 400 000	2 500 000	2 700 000	3 000 000
India (e)	13 023	12 393	14 008	5 538	2 203
Iran (b)	55 187	41 094	41 220	64 601	...
Korea, Dem. P.R. of	*12 000	*12 000	*12 000	*12 500	*12 500
Kyrgyzstan	2 656	3 973	*4 000	*4 000	*4 000
Mongolia	185 100	198 400	148 200	134 100	138 000
Pakistan (c)	1 288	*1 000	1 026	1 040	*1 050
Thailand	2 270	2 360	2 375	295	3 240
Vietnam	*3 000	*3 000	*3 000	*3 000	*3 000
World Total	4 700 000	4 500 000	4 700 000	5 100 000	5 500 000

Note(s):-

- (1) In addition to the countries listed, Bulgaria is believed to produce fluorspar
(2) In addition, the USA produced the following amounts of fluorspar equivalent in fluorosilicic acid derived from processing phosphate rock ('000 t): 2002: 92; 2003: 94; 2004: 90; 2005: 86; 2006: 70

- (a) Including beneficiated and directly shipped material
(b) Years ended 20 March following that stated
(c) Years ended 30 June of that stated
(d) Exports
(e) Years ended 31 March following that stated

Production of germanium metal

tonnes

Country	2002	2003	2004	2005	2006
USA (a)	5	5	4	5	5
China	*20	*20	*20	*20	...
Japan	1	1	1	2	2

Note(s):-

- (1) Significant quantities of germanium are also believed to be recovered from imported or domestic material in France, Germany, Russia and to a lesser extent in Italy

- (a) Including production of secondary metal

GOLD

Characteristics

Gold is a soft, malleable, bright yellow metallic element unaffected by air or most reagents. Gold occurs in its native state or in combination with other elements such as silver. Gold is highly valued as an asset or investment commodity and is extensively used in jewellery and for industrial applications.

Uses

Gold is a long-established, universally accepted store of value, widely traded internationally. Gold is seen as a safe haven in times of financial and political uncertainty since it is not at risk of becoming worthless unlike currency and other assets. Gold is increasingly being used to diversify investment portfolios, as a currency and as a hedge against inflation. The centre of world gold trading is the London Bullion Market, on which the gold price is fixed twice daily. The fix is used as a benchmark for pricing the majority of gold products and derivatives throughout the world's markets. Jewellery production accounts for the largest use of gold, representing around 70 per cent of total demand (World Gold Council, 2006a). In Asia and the Middle East gold jewellery is commonly bought as an investment or store of value. Gold has a wide range of industrial uses, dominated by the electrical sector, in which it is valued for its excellent thermal and electrical properties. A significant amount of gold is consumed in dentistry and it also has medical applications. Research is continually finding new applications for gold including catalysts and in nanotechnology.

World production in 2006

Gold production is recorded in more than 80 countries and several countries produce substantial quantities of gold from small operations which are not recorded in official statistics. Seven countries produce more than a 100 000 kilograms (metal content) of gold annually, or more than half of world mine production. World mine production, which had been rising for around 20 years, peaked in 2000 at 2560 tonnes. Annual mine production in 2006 was 2310 tonnes, a fall of 250 tonnes in six years. High gold prices in the late 1970s and early 1980s resulted in steadily increasing global production to the peak in 2000. Production subsequently levelled out and began to decline reflecting the low gold price between 1997 and 2001, investor uncertainty resulting from the Bre-X scandal (a major mining fraud) and diminishing reserves. The depressed gold price led to a lack of exploration and development during this period, resulting in very few new discoveries and depletion of reserves. Following this period of declining exploration budgets, which reached a low in 2002, exploration expenditure began to increase in response to dwindling gold reserves, higher gold prices and increasing investor interest. Global mine production did not start to increase until 2005 when it reached 2440 tonnes, reflecting the significant lag time required to bring projects into production.

South Africa has dominated world gold production for many decades and in 1970 was producing over 1000 tonnes annually, equating to 60 per cent of world production. South African output has since been declining whilst many other countries have expanded production. Despite this, South Africa remains the world's largest gold producer, producing 272 tonnes in 2006, or 12 per cent of world mine production. The decline in South African gold production is attributed to the mature nature of the mines and declining reserves, high production costs and accidents. China's gold production has increased dramatically in recent years and China closely

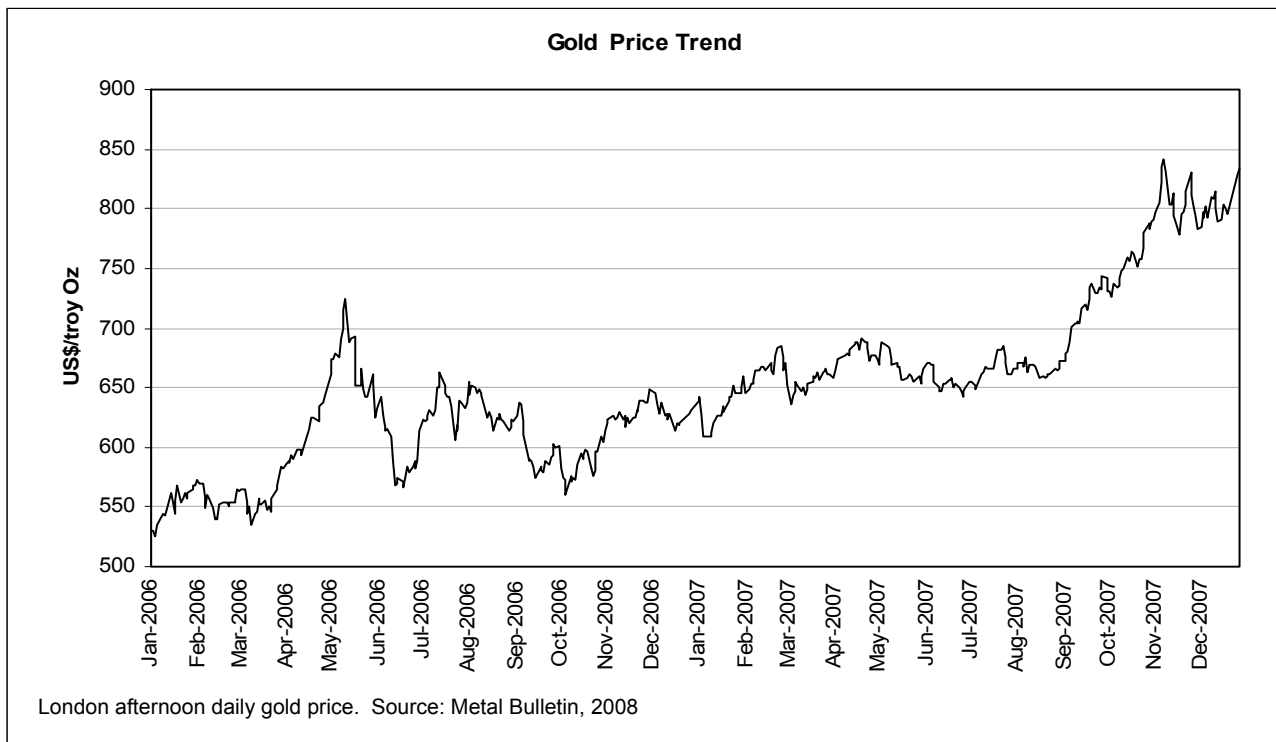
follows South Africa as the world's second largest gold producer in 2006, with an output of 247 tonnes. China's gold production has increased by 22 per cent in the last five years and is expected to exceed South African production in the near future. The Chinese Government has been highly supportive of gold exploration leading to a rapidly expanding resource base (Mining Journal, 2007a). The traditionally dominant gold producers of South Africa, Australia, USA and Canada are rapidly losing ground to new producers that have become increasingly important in recent years. Gold output of these countries declined by 8, 6, 5 and 13 per cent respectively in 2006. Indonesia has experienced an exceptional rise in production from only three tonnes in 1985 to 143 tonnes in 2005, largely from the giant Grasberg mine (World Gold Council, 2006b). Notably Indonesian production fell by more than 57 tonnes in 2006 to 85 tonnes as a result of a sharp reduction in the ore grade at Grasberg (O'Connell, 2007a). Peru, which is now the world's fifth largest gold producer, has increased production from 24 tonnes in 1992 to 203 tonnes in 2006, thanks to new large-scale mines such as Yanacocha.

Prices

The gold market is characterised by substantial above-ground reserves, held mainly by banks. If some of these are released into the world market the gold price may be significantly affected. The gold price can be volatile but has strengthened in recent years due to declining mine output, increasing jewellery demand, extensive speculative activity and new gold investment products, devaluation of the US dollar (which underpins the gold price), lower interest rates and geopolitical tensions. All gold prices quoted are based on the London afternoon daily price, in US dollars per troy ounce, as quoted by Metal Bulletin.

Following a period of depressed gold prices between 1987 and 1999, when the price of gold fell by 40 per cent the gold market has significantly improved in recent years. Since 2001, the gold price has more than doubled, rising from an average annual price of US\$271 per ounce to US\$695 per ounce in 2007. The gold price continued its upward trend during 2006, exceeding US\$600 per ounce in April, its highest level since 1980, driven by strong investor demand, a weak US dollar, strong oil prices and geopolitical tensions between the US and Iran. Sustained investor and speculator activity pushed the gold price to a 26-year high of US\$725 per ounce in mid-May 2006. The price fell significantly during June to US\$567, a fall of 22 per cent as the US dollar strengthened and investors sold gold into the market. The gold price rebounded during July as renewed investor interest pushed gold in to the mid-600 dollars per ounce range. The price subsequently fell in October to US\$560 before rebounding to US\$632 per ounce at year-end, with an average annual price of US\$604 in 2006.

Following a weak start to 2007 the gold price climbed to US\$685 per ounce at the end of February, supported by investment demand in response to record oil prices and geopolitical and inflationary concerns. Investment demand and a perceived supply-demand shortfall continued to drive gold prices which climbed to above US\$690 per ounce in April. Prices fell to US\$642 by the end of June as a result of central bank gold sales, a strengthening US dollar and interest rate concerns (Rumley, 2007). The gold price increased during July, peaking at US\$684 per ounce as the US dollar dropped to record lows against the pound and Euro (Frei, 2007). During August concerns over the US sub-prime lending market and a growing credit crisis caused widespread selling of financial assets including gold, forcing the gold price below US\$660 in



mid-August. Between late August and late September the gold price increased substantially to US\$743 per ounce, in response to the weak US dollar and news that the US Federal Reserves would cut interest rates. During the final quarter of 2007 the gold price accelerated upwards, reaching US\$789 at the end of October, driven by escalating oil prices and the weakening US dollar. In early November as the oil price approached US\$100 per barrel, the gold price hit a 28-year high, of US\$841. The fluctuating strength of the dollar during the second half of November ensured price volatility around the US\$800 per ounce mark. Having ended November at around US\$780 the gold price fluctuated during December, finishing the year at US\$833 per ounce, a 30 per cent increase during 2007.

Industry events in 2007

Dehedging, a process whereby producers settle forward sales obligations, was a prominent feature of the gold market in 2007. Since 2000 the increasing difference between lower forward selling prices and rising spot gold prices has led to producers reducing their volume of forward sales (Berg, 2007; Pieterse, 2007). Dehedging, impacts on the spot market by effectively reducing the amount of global mine production available (Berg, 2007). Dehedging reached record levels in 2007 as mining companies sought to reduce their hedge books (Kruger, 2007).

European central bank gold sales approached the maximum, self-imposed limit of 500 tonnes per annum during 2007, with major contributions by the central banks of Spain, France and Switzerland (O'Connell, 2007b). In 2007 concerns were raised about the quality of the Bank of England's gold stocks. The Bank holds around 320 tonnes in reserve but not all of this metal appears to conform with standards defined by the London Bullion Market Association (Lawlor, 2007; Nikkhah, 2007).

A number of new mines came on stream or moved to full production in 2007. Newmont's newly opened Ahafo mine in Ghana and Phoenix and Leeville mines in Nevada entered their first year of full production in 2007 (Rumley, 2007). Barrick's Ruby Hill mine, Nevada, recommenced production in early 2007 (Barrick, 2007). Gold production commenced at Sino Gold's Jinfeng mine, in China, in mid-2007 (Sino Gold,

2007). In 2007, China announced the discovery of what is claimed to be one of Asia's largest gold deposits in the north-east of the country (Mining Journal, 2007b). BHP Billiton has announced an increase of 77 per cent by tonnage in the total resource estimate for its Olympic Dam mine, the largest gold resource in Australia and a US\$6 billion expansion is planned (BHP Billiton, 2007; Mercer, 2007). Buoyant prices during 2007 ensured that gold dominated mineral exploration expenditure, accounting for 41 per cent of worldwide exploration budgets (MEG, 2007).

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Mine production of gold

kilograms (metal content)

Country	2002	2003	2004	2005	2006
Armenia	3 200	1 800	1 881	1 550	*1 500
Bulgaria	2 612	2 270	2 431	3 868	3 818
Finland	1 300	*1 200	*1 300	*1 300	*1 300
France	1 724	1 470	—	—	—
Georgia	2 876	2 386	1 377	1 620	*1 600
Greenland	—	—	1 560	1 828	2 800
Italy	631	*100	—	—	—
Poland (d)	296	356	527	713	*1 700
Romania	1 137	1 878	1 430	*500	*500
Russia	168 393	170 068	169 297	163 186	159 340
Serbia	—	—	—	—	*330
Serbia and Montenegro (d)	858	363	328	*330	—
Slovakia	77	79	107	109	84
Spain	5 559	5 417	5 248	2 145	1 565
Sweden	5 757	5 900	6 564	6 564	6 848
Turkey	*4 500	5 370	3 260	—	2 205
Algeria	369	365	597	641	377
Botswana	8	9	162	2 709	3 020
Burkina Faso	209	780	1 008	1 397	1 571
Burundi	483	2 855	3 229	3 905	4 313
Cameroon	700	700	600	600	*600
Congo	10	75	160	120	100
Ethiopia (b)	3 670	3 875	3 490	3 726	3 828
Gabon	*70	*70	300	*300	*300
Ghana	69 575	70 756	63 140	66 530	66 205
Guinea	16 666	16 631	15 236	17 474	16 336
Ivory Coast	3 570	1 313	1 219	1 638	*1 600
Kenya (e)	1 477	1 543	567	616	432
Madagascar	2 802	10	0	—	—
Mali	56 019	45 529	37 916	44 156	50 773
Morocco (d)	2 747	1 863	1 493	*1 500	*1 500
Namibia	2 947	2 508	2 205	2 649	2 790
Niger	28	30	1 531	4 922	*5 500
Senegal	*600	*600	*600	*600	*600
South Africa	398 258	372 766	337 223	294 803	272 128

Mine production of gold

kilograms (metal content)

Country	2002	2003	2004	2005	2006
Sudan	5 258	*5 500	*5 000	4 739	*4 500
Tanzania	43 320	48 018	48 176	47 270	39 750
Uganda (e)	7 590	4 160	1 447	1 500	*1 500
Zambia (c)	*140	*140	*160	*170	*180
Zimbabwe	15 669	11 514	21 330	13 453	11 354
Canada	152 059	141 589	130 727	120 541	104 198
Costa Rica	*100	*110	*150	424	*2 500
Cuba	*1 000	547	*500	*500	*500
Guatemala	*4 500	4 550	—	741	5 036
Honduras	4 984	4 494	3 683	4 439	4 055
Jamaica	159	146	20	—	—
Mexico	21 324	20 406	21 818	26 782	35 899
Nicaragua	3 494	3 096	4 064	3 674	3 395
USA	298 000	276 897	257 905	255 757	*242 000
Argentina	32 530	29 748	28 496	27 904	44 131
Bolivia	11 269	9 361	6 165	8 871	9 628
Brazil	41 662	40 416	47 596	38 293	40 075
Chile	38 688	38 954	39 986	40 447	42 100
Colombia	20 823	46 515	37 738	35 783	15 683
Ecuador	2 750	4 819	5 158	5 228	*5 280
French Guiana	3 290	3 296	2 773	1 955	*2 000
Guyana	14 104	12 171	11 478	8 325	6 405
Peru	157 298	172 619	173 219	207 822	203 269
Suriname	—	—	8 513	10 619	10 426
Uruguay	2 079	1 550	1 758	2 930	*2 800
Venezuela	9 465	8 190	9 690	*10 000	*13 200
Burma (d)	*100	*100	*100	*100	*100
China (d)	202 000	210 100	212 350	229 800	247 200
India (a)	3 153	3 457	3 526	3 050	2 362
Indonesia	142 238	141 019	92 936	143 205	85 411
Iran (d)	650	*500	*900	275	250
Japan	8 563	8 122	7 936	8 319	8 904
Kazakhstan (d)	10 959	9 906	9 576	9 788	*10 000
Korea, Republic of	188	528	233	260	277
Kyrgyzstan	17 000	22 476	21 395	16 751	10 721
Laos	—	5 140	4 392	6 232	5 397
Malaysia	4 289	4 739	4 221	4 250	3 497
Mongolia	12 097	11 119	19 418	24 122	22 561
Oman	188	4	—	—	—
Philippines	36 005	37 844	35 464	37 490	36 098
Saudi Arabia	4 600	8 500	8 268	7 456	5 182
Tajikistan	*2 700	2 370	2 161	1 927	1 920
Thailand	4 950	4 269	4 507	4 393	3 470
Uzbekistan	85 636	84 610	88 350	84 210	*84 000
Vietnam	*2 000	*2 000	*2 000	*3 000	*3 000
Australia	266 140	282 000	259 000	263 000	247 000
Fiji	3 829	3 517	4 033	2 793	1 403
New Zealand	9 770	9 305	10 151	10 583	10 618
Papua New Guinea	61 379	67 832	73 670	68 483	58 349
World Total	2 530 000	2 530 000	2 400 000	2 440 000	2 310 000

Note(s):-

- (1) In several countries substantial amounts of gold produced in small operations are not recorded in the official statistics used when compiling this table
- (2) In addition to the countries listed, Central African Republic, Eritrea, Liberia, Mozambique, Nigeria, Sierra Leone, Solomon Islands, Taiwan and Ukraine produce less than 100 kg gold per year
- (3) Greece and Norway are believed to produce gold

- (a) Years ended 31 March following that stated
- (b) Years ended 7 July of that stated
- (c) Contained in blister copper, refinery muds and electrolytic copper
- (d) Metal production
- (e) Exports

Production of graphite

tonnes

Country	2002	2003	2004	2005	2006
Czech Republic	16 000	9 000	5 000	3 000	5 000
Germany	3 312	2 840	3 155	2 638	—
Norway	8 600	1 000	6 000	9 000	9 000
Romania	1 001	1 014	395	486	—
Russia	14 241	12 780	13 550	*14 000	*14 000
Turkey	1 393	942	*1 000	*1 100	*1 200
Ukraine	9 400	11 000	10 960	10 400	5 800
Madagascar	7 522	2 170	7 770	*7 700	*7 700
Zimbabwe	9 700	6 280	10 267	4 298	6 588
Canada	15 039	12 500	*15 000	*17 000	*14 000
Mexico	14 065	8 730	14 769	12 357	11 773
Brazil (b)	60 922	70 739	76 332	75 515	76 194
China (d)	1 320 000	1 400 000	1 450 000	1 650 000	1 730 000
India (a) (c)	106 060	87 207	108 150	120 322	122 465
Korea, Dem. P.R. of	*25 000	*25 000	*30 000	*30 000	*30 000
Korea, Republic of	94	58	247	39	68
Sri Lanka	3 619	3 387	5 374	4 370	5 756
World Total	1 600 000	1 700 000	1 800 000	2 000 000	2 000 000

Note(s):-

- (1) This table includes all forms of amorphous and crystalline graphite but excludes synthetic material
(2) In addition to the countries listed, Egypt, Namibia and the USA are believed to produce graphite

- (a) Crude
(b) Including beneficiated and directly shipped material
(c) Years ended 31 March following that stated
(d) Including flake graphite

Production of gypsum

tonnes

Country	2002	2003	2004	2005	2006
Armenia	44 943	57 835	...	...	...
Austria					
Gypsum	847 117	889 727	920 809	911 162	936 072
Anhydrite	122 085	113 823	117 318	106 032	135 380
Azerbaijan	1 039	3 848	884	28 242	35 034
Bosnia & Herzegovina	*60 000	143 047	139 520	152 939	128 399
Bulgaria	156 400	165 500	175 900	187 700	215 800
Croatia	145 000	166 340	193 263	196 133	170 351
Cyprus	295 000	300 000	255 000	215 500	270 000
Czech Republic	108 000	104 000	71 000	25 000	16 000
France	*4 900 000	*5 600 000	*5 700 000	4 902 498	*4 800 000
Georgia	8 127	8 507	1 707	238	123
Germany (a)	1 761 000	1 748 000	1 579 000	1 644 000	1 771 000
Greece	890 148	731 785	856 606	865 216	*860 000
Hungary (a)	108 000	62 000	55 000	19 000	18 000
Irish Republic	*500 000	*600 000	*650 000	*700 000	*700 000
Italy	1 531 477	1 783 903	1 615 287	*1 600 000	*1 600 000
Latvia (a)	217 074	159 133	225 742	*220 000	*230 000
Macedonia	129 266	150 618	165 416	190 232	267 760
Moldova	91 300	116 100	491 000	562 700	725 900
Poland					
Gypsum	866 674	1 030 693	970 786	1 048 000	(a) 1 361 509
Anhydrite	217 000	197 000	196 000	195 000	...
Portugal	579 143	419 799	461 212	389 180	366 599
Romania	421 235	409 516	490 372	532 867	598 940
Russia	1 389 800	1 766 600	2 076 800	*2 200 000	*2 200 000
Serbia	—	—	—	—	*42 000
Serbia and Montenegro	54 937	42 261	42 471	*42 000	—
Slovakia (a)	121 680	93 800	127 100	107 500	126 200
Spain	11 218 410	11 366 375	12 533 972	12 500 000	*12 500 000
Switzerland	*300 000	*300 000	*300 000	*300 000	*300 000
Turkey	264 038	196 668	250 099	*250 000	*250 000
Ukraine	288 000	461 000	601 000	656 000	375 900
United Kingdom	*1 700 000	*1 700 000	1 686 000	*1 700 000	*1 700 000
Algeria	741 000	*800 000	467 352	857 502	1 033 107
Egypt	119 453	...	...	...	*120 000
Eritrea	1 062	2 705	1 054	212	396
Ethiopia (d)	22 500	48 058	51 200	34 729	38 809
Kenya	*9 000	*10 000	*11 000	*11 000	*11 000
Libya	*150 000	*150 000	*175 000	*175 000	*175 000
Mauritania	*40 000	*40 000	*40 000	43 266	45 222
Morocco	*600 000	*600 000	*600 000	*600 000	*500 000
Niger	17 652	17 851	34 944	17 417	*17 500
Somalia	*1 500	*1 500	*1 500	*1 500	*1 500
South Africa	415 387	394 069	452 271	547 581	554 020
Sudan	*5 000	*5 000	*5 000	*5 000	*5 000
Tanzania	78 650	33 232	59 231	23 119	32 556
Tunisia	*100 000	*100 000	109 000	113 000	*115 000
Canada					
Gypsum	9 006 000	(a) 8 925 000	(a) 9 205 000	(a) 8 272 000	(a) 9 072 000
Anhydrite	93 239	...	...	...	...
Cuba	*110 000	*110 000	*110 000	*110 000	*110 000
Dominican Republic	178 941	219 311	435 723	352 242	238 429
El Salvador	*6 000	*6 000	*6 000	*6 000	*6 000
Guatemala	94 411	66 981	106 140	349 589	226 800
Honduras	*60 000	*60 000	*60 000	*60 000	*60 000
Jamaica	164 880	248 558	283 352	302 066	364 432
Mexico	6 703 109	6 986 491	9 221 458	6 251 969	6 075 893
Nicaragua	28 153	30 642	36 466	36 456	42 191
USA	15 700 000	16 700 000	17 200 000	21 100 000	*21 200 000

Production of gypsum

tonnes

Country	2002	2003	2004	2005	2006
Argentina	362 556	387 936	674 935	1 073 286	1 202 812
Brazil	1 633 311	1 529 015	1 474 911	1 582 248	1 737 220
Chile	609 550	662 259	630 444	660 753	845 331
Colombia	*560 000	*560 000	*560 000	*560 000	*560 000
Ecuador	4 730	5 203	232	1 310	*1 000
Paraguay	*4 300	*4 500	*4 500	*4 500	*4 500
Peru	75 306	136 642	432 259	334 595	394 289
Venezuela	10 000	5 000	4 000	6 000	*7 000
Afghanistan	*3 000	*3 000	*3 000	*2 000	*2 000
Bhutan	105 658	122 829	131 236	150 585	*160 000
Burma (f)	90 002	66 069	71 155	67 522	*68 000
China	25 500 000	27 500 000	29 520 000	32 000 000	35 000 000
India (e) (f)	2 672 244	2 793 553	3 689 927	3 137 095	2 647 000
Indonesia	6 000	6 000	6 000	*6 000	*6 000
Iran (c)	8 338 725	11 979 513	14 394 537	11 195 745	*11 000 000
Israel	123 119	141 000	124 678	106 798	110 754
Jordan	11 252	63 895	135 331	344 911	333 710
Kazakhstan	...	...	396 200	516 600	...
Laos	119 514	101 727	201 094	131 508	*150 000
Mongolia	*25 000	*25 000	30 050	81 223	60 400
Oman	55 722	*50 000	*60 000	*60 000	*60 000
Pakistan (b)	402 600	424 107	467 065	552 496	601 027
Saudi Arabia	497 155	491 132	*500 000	*500 000	*500 000
Syria	350 088	376 715	431 561	467 000	443 800
Tajikistan	...	50 100	57 000	8 500	...
Thailand					
Gypsum	6 325 591	7 291 167	7 619 205	7 113 073	8 354 901
Anhydrite	290 885	448 071	531 660	537 781	560 339
Uzbekistan	*80 000	*80 000	*80 000	*80 000	*80 000
Vietnam	*5 000	*5 000	*5 000	*5 000	*5 000
Yemen, Republic of	41 000	42 000	*44 000	...	...
Australia (b)	4 087 500	3 937 700	4 170 873	*3 833 358	*4 186 716
World Total	116 600 000	126 200 000	138 200 000	137 000 000	142 500 000

Note(s):-

(1) Some countries produce large quantities of synthetic gypsum. Where possible, this output is excluded from the table

(a) Including anhydrite

(b) Years ended 30 June of that stated

(c) Years ended 20 March following that stated

(d) Years ended 7 July of that stated

(e) Including selenite

(f) Years ended 31 March following that stated

Production of iodine

kilograms

Country	2002	2003	2004	2005	2006
Russia	58 000	58 000	105 000	*105 000	*105 000
USA	1 420 000	1 090 000	1 130 000	1 570 000	*1 220 000
Chile	11 648 000	13 916 000	14 931 000	15 346 000	16 494 000
China	*500 000	*500 000	*550 000	*550 000	*560 000
Indonesia	*75 000	*75 000	*75 000	*75 000	*75 000
Japan	6 548 000	6 524 000	7 264 000	8 095 000	*8 000 000
Turkmenistan	*200 000	*200 000	*200 000	*270 000	*270 000
Uzbekistan	*2 000	*2 000	*2 000	*2 000	*2 000
World Total	20 500 000	22 400 000	24 300 000	26 000 000	26 700 000

IRON ORE

Characteristics

The pure form of iron is a lustrous silver metal with a greyish tinge. It readily oxidises in air and is only very rarely found as native metal. As a ferromagnetic element it has magnetic properties. Iron is abundant (around five per cent) in the Earth's crust and its minerals vary greatly in their composition and appearance. The most common ore minerals are the oxides which can vary in colour from grey to yellow or red; particularly magnetite (Fe_3O_4) and hematite (Fe_2O_3). Other common ores include the hydrated oxides, goethite ($\text{FeO}(\text{OH})$) and limonite ($\text{FeO}(\text{OH}) \cdot n\text{H}_2\text{O}$), and the carbonate mineral siderite (FeCO_3). The most economically important iron ore deposits are known as banded iron formations (BIF). These are found in Proterozoic rocks (2500–524 million years old) formed by deposition of iron oxides on the sea bed in an ancient reducing environment. The largest examples are from the Hamersley Province, Western Australia and the Lake Superior District, USA. Economic deposits are usually those that have been secondarily enriched by natural processes to grades of around 65 per cent iron. Magmatic deposits can also be the source of large quantities of magnetite where the mineral is segregated in a large magma chamber; the largest magmatic iron ore deposit is at Kiruna in Sweden. World reserves of iron ore are 150 000 million tonnes of ore containing 73 million tonnes of iron. Ukraine holds the world's largest reserves of ore with 30 000 million tonnes (19 per cent of the world total). Russia is the second largest and China the third with 25 000 and 21 000 tonnes respectively (USGS 2008).

Uses

Around 98 per cent of iron ore is used to make steel and goes directly to primary steel plants. The ore is first smelted to iron — known as pig iron — before it is processed into steel. The iron product can be in the form of blast furnace iron (BFI) where the ore is smelted with limestone and coke to produce liquid iron or direct reduced iron (DRI). Here the ore is heated and reduced using natural gas to produce iron pellets. Scrap iron and steel is melted in an electric arc furnace. To produce steel, liquid iron is treated in a converter to reduce its carbon content and adjust the alloy composition. Steel has numerous varied uses and, depending on the alloy, many different properties. The most common steel alloys are plain-carbon steel (up to 2.1 per cent carbon), stainless steel (alloyed with chromium and nickel), high-strength low-alloy steel (HSLA) with low levels of carbon, and tool steel, which is very hard due to heat-treatment.

Pig iron can also be re-melted, reducing the carbon and silicon contents, to produce cast iron; this is more brittle than steel but is suitable for many engineering uses such as machine and car parts (such as engine blocks), street furniture, and pipes.

The remaining two per cent has many other minor uses including use as a pigment, as an additive to cement, as magnets, in industrial processes, an ingredient in fertilizers, in catalysts or as a radioactive tracer for use in medicine or biochemical research.

World production in 2006

World production of iron ore rose to 1810 million tonnes in 2006, a 16 per cent increase on 2005. Increase in production was driven by high demand from China and to a lesser extent

India. The consequent price increases have led to operators increasing production capacity and investing in new mines. Production still struggles to catch up with world demand. The highest iron ore production rates ever were recorded in 2006 for the fifth consecutive year with production rising by 62 per cent since 2002. China was once again the world's highest producer with a 40 per cent increase in production, increasing by 153 per cent in the last 5 years. This increase has mainly been achieved by heavy investment at existing operations by big companies and a very fast expansion by small producers as well as technological breakthroughs leading to development of new low grade mines; the increase could slow in future years however due to new regulations leading to the phasing out of many smaller less efficient operations. Brazil, the world's second largest producer increased production by 13 per cent, mainly due to Vale (formerly CVRD), the country's biggest producer, increasing production at existing mines, expanding the Carajás mine and to the startup of the Fábrica Nova and Brucutu Mines.

Australia, the world's third largest producer, increased its production by five per cent in 2006 compared to 2005, however this is a slowdown compared to the increase of 12 per cent seen in 2004–2005. Unprecedented bad weather in Australia, with five cyclones, caused damage, flooding and delays to many operations early in the year. These problems were further compounded by labour shortages. BHP Billiton and Rio Tinto both increased their production levels in Australia with both companies expanding several mines.

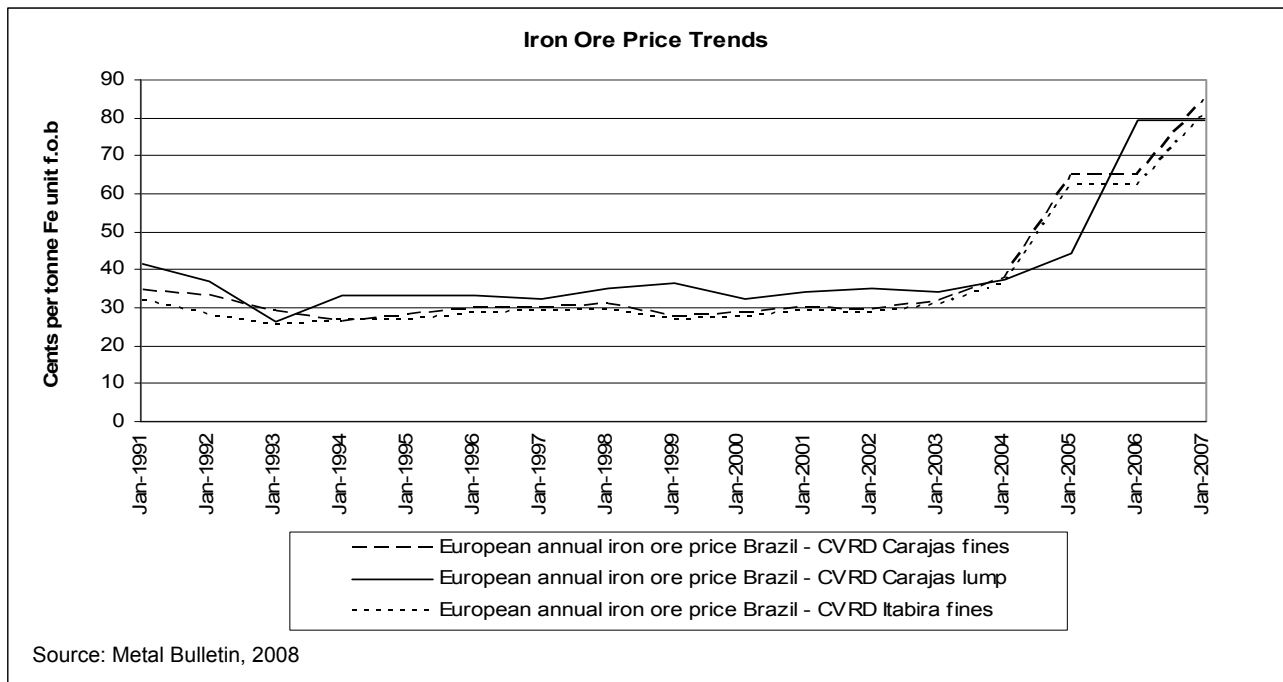
Only modest increases were seen in African production. In South Africa, the world's eighth largest producer, production rose by five per cent compared to 2005. This figure was mirrored by most other African producers except Algeria, which rose by 25 per cent, and Zimbabwe, which fell by 53 per cent due to increasing political instability.

The growth in European production was below the world average with an 11 per cent increase during 2002 to 2006, this is due largely to competition from increased production in Russia and Ukraine. Here production levels at existing sites have been increased but it is predicted that they have now reached capacity and big investments in new sites will be required to maintain their growth.

Production in North America fell by three per cent. However Canada, the world's ninth largest producer, increased production by 20 per cent due to record production from the Carol mine in Labrador.

Prices

Iron ore trade is characterised by consumers having fixed contracts with producers negotiated annually. Rarely will iron ore be traded with spot prices on the open market. The price of iron ore remained relatively constant for the last decade until 2004, when prices rose by 19 per cent. In 2005 this increased again by 70 per cent, prices stabilised in 2006 and rose again by 30 per cent in 2007 rising throughout the year. This rise, mainly driven by Chinese demand, pushed spot iron ore prices so high above contract prices by the end of 2007 (around £50 per tonne according to Rio Tinto) that major producers Rio Tinto and BHP Billiton made plans to sell considerably more iron on the spot market.



Industry events in 2007

This was a very positive year for iron ore production where growth was almost worldwide. This was coupled with large price increases, in the last half of the year, as Chinese demand drove up the share price of almost all major iron ore mining companies despite problems with the American economy. The three major iron ore producers Vale (formerly CVRD), Rio Tinto and BHP Billiton all announced significant production capacity increases. Vale announced plans to increase capacity by 50 per cent over the next four years by fast-tracking expansion plans from 300 million tonnes per year to 450 million tonnes per year by 2011. BHP Billiton and Rio Tinto have similar plans, investing larger amounts in their Western Australia operations. Rio Tinto announced two changes to their production targets this year: the first, in June, was an increase in production from 220 million tonnes a year to between 300 and 320 million tonnes a year by 2009; and the second, in November, a longer term increase to a total of 600 million tonnes a year in the next two decades. This is to be done mainly by increasing production and opening new mines in the Pilbara region of Australia where production rates could reach 420 million tonnes per year. Many dormant operations are being revived; the year saw the start of iron ore exports from Australia's Northern Territory for the first time in 13 years.

Chinese producers began a significant programme of foreign investments with several of the nation's top steel mills forming overseas joint ventures, notably in Australia, USA, Asia and Africa. One of the largest was an investment in a northern Cambodian iron ore mine with 200 million tonnes of reserves. In Australia, Baotou and Shenyang Orient iron and steel have agreed to buy one million tonnes of ore from the Wilgerup hematite deposit, South Australia.

In early 2007, the imbalance in supply and demand of iron ore production was predicted to end by 2009 possibly with iron ore production outstripping demand. However, now it is thought that project delays could maintain the current iron ore boom until 2011.

High demand has resulted in prices on the spot market being almost twice the value of contract prices, leading to more ore being sold on the spot market. Rio Tinto has announced plans

to sell 15 million tonnes of ore on the spot market in 2008, although contract prices are predicted to rise next year by between 30 per cent and 50 per cent. Increased shipping cost from Brazil to China has also led to substantial differences in the prices of Brazilian ore and Australian ore at Chinese ports. BHP Billiton and Rio Tinto have attempted to alter the pricing system as a result but have met with strong resistance from the Chinese. Vale has ordered four new very large ore carriers to try to reduce costs.

Consolidation in the iron ore industry grew in 2007, promoted by price increases and positive forecasts, with the 15 largest companies controlling almost 60 per cent of production. Vale took over several smaller Brazilian companies. Brazilian producer MMX sold stakes in two major projects to Cleveland-Cliffs (in late 2006) and Anglo American, with Anglo paying £618 million. Many steel companies tried to buy into iron ore as a hedge against increasingly high prices, Arcelor Mittal making the biggest move by buying into the Wabush mine in Canada. The company aims to be 75 per cent self-sufficient eventually and has begun to invest heavily in Africa. Another Indian Steel maker, Jindal Steel, has signed a £1.05 billion contract to develop the El Mutan deposit in Bolivia, which is estimated to contain 40 billion tonnes of ore. BHP Billiton proposed a bid for Rio Tinto, which if successful, would create the world's second largest producer. This would have potentially far-reaching consequences for the iron ore industry and the proposal met opposition from European, Chinese and Australia steel manufacturers with concerns about an iron ore monopoly.

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Production of iron ore

tonnes

Country	2002	2003	2004	2005	2006
Austria (a)	1 941 759	2 124 787	1 889 419	2 047 950	2 091 995
Azerbaijan	4 000	3 100	19 100	7 300	11 300
Bosnia & Herzegovina	212 000	126 929	280 596	3 045 654	3 439 587
Bulgaria	373 000	466 100	82 700	—	—
France	21 367	—	—	—	—
Germany (f) (b)	419 371	429 170	412 238	362 106	411 973
Norway	490 000	410 000	586 100	713 000	620 000
Romania	248 000	244 000	231 417	220 788	...
Russia	85 964 300	92 604 600	94 894 600	96 828 000	104 000 000
Slovakia	326 300	287 000	305 072	258 500	...
Spain	24 489	571	10 879	—	—
Sweden	20 281 000	21 498 000	22 272 000	23 255 000	23 302 000
Turkey	3 432 775	3 429 070	3 856 536	3 889 934	3 251 968
Ukraine	59 300 000	62 500 000	66 000 000	69 456 000	74 000 000
United Kingdom	464	*500	*500	354	341
Algeria	1 162 000	1 426 200	1 754 300	1 878 800	2 339 637
Egypt (d)	2 618 065	*2 900 000	2 237 475	*2 500 000	*2 500 000
Mauritania	9 554 000	10 153 000	10 674 000	10 752 000	11 155 000
Morocco	8 736	4 019	...	...	...
Nigeria	7 850	8 635	8 479	*8 000	*8 000
South Africa (c)	36 484 015	38 085 855	39 322 048	39 542 072	41 326 036
Tunisia	202 000	160 300	256 000	206 400	217 300
Zimbabwe	271 812	411 044	228 731	224 229	104 459
Canada (g)	28 704 000	33 013 000	28 596 000	28 343 000	34 094 000
Cuba	19 400	18 400	19 700	18 900	7 800
Mexico	9 966 000	12 398 000	13 369 000	14 468 000	14 568 000
USA	51 570 000	48 554 000	54 724 000	54 300 000	52 900 000
Brazil	214 560 000	234 478 000	261 696 128	281 462 088	317 800 229
Chile	7 268 803	8 011 023	8 003 491	7 862 000	8 629 000
Colombia	688 106	625 002	507 711	607 559	644 015
Peru	4 566 000	5 228 804	5 228 800	5 614 900	5 885 000
Venezuela	16 595 634	17 954 495	19 196 231	21 179 000	*21 000 000
Bhutan	—	—	—	5 679	*5 300
China	232 619 000	261 084 600	310 104 800	420 492 700	588 171 400
India (h)	99 072 000	122 838 000	145 942 000	154 436 000	173 976 000
Indonesia	378 587	245 409	89 664	32 203	10 936
Iran (e)	16 906 035	18 287 228	18 204 658	22 327 000	*22 000 000
Kazakhstan	17 675 100	19 364 600	20 302 500	19 471 100	*20 000 000
Korea, Dem. P.R. of	*1 000 000	*1 100 000	*1 100 000	*1 200 000	*1 200 000
Korea, Republic of	156 774	174 009	226 287	212 971	227 437
Malaysia (g)	404 350	596 612	663 732	949 605	667 082
Pakistan (d)	6 562	11 773	84 946	104 278	131 259
Thailand	570 110	9 675	135 580	230 946	264 289
Vietnam	533 800	711 900	1 205 400	1 435 000	*1 500 000
Australia	188 760 000	212 881 000	234 002 000	261 796 000	275 042 000
New Zealand	1 739 950	1 946 913	2 329 417	2 207 244	2 146 496
World Total	1 117 000 000	1 237 000 000	1 371 000 000	1 554 000 000	1 810 000 000

Note(s):-

- (a) Including micaceous iron oxide
- (b) Used as aggregate in the construction industry
- (c) Including by-product magnetite
- (d) Years ended 30 June of that stated
- (e) Years ended 20 March following that stated
- (f) Including manganiferous iron ore
- (g) Including by-product iron ore
- (h) Years ended 31 March following that stated

Production of pig iron

tonnes

Country	2002	2003	2004	2005	2006
Austria	4 607 000	4 676 742	4 846 740	5 446 000	5 548 000
Belgium	7 988 396	7 812 593	8 224 000	7 254 000	7 515 000
Bosnia & Herzegovina	*60 000	*60 000	*60 000	*60 000	*60 000
Bulgaria	1 072 000	1 386 000	1 200 000	1 100 000	1 100 000
Czech Republic	4 839 880	5 207 000	5 385 000	4 627 000	5 192 000
Finland	2 828 275	3 092 051	3 036 566	3 056 165	3 157 894
France	13 093 042	12 615 893	13 087 705	12 595 584	12 873 900
Germany	29 967 000	30 071 000	30 628 000	29 294 000	30 360 000
Hungary	1 334 000	1 332 000	1 350 000	1 329 000	1 336 000
Italy	9 746 000	10 123 000	10 566 000	11 392 000	11 479 000
Netherlands	5 367 000	5 846 000	6 011 000	6 031 000	5 417 000
Norway	108 000	*110 000	*100 000	*100 000	*100 000
Poland	5 296 410	5 585 094	6 292 341	4 476 831	5 332 632
Romania	3 979 346	4 101 409	4 243 956	4 097 998	3 941 035
Russia	49 161 000	51 235 000	53 461 000	51 750 000	51 763 000
Serbia	—	—	—	—	1 765 000
Serbia and Montenegro	485 391	635 182	959 019	1 115 195	—
Slovakia	3 533 150	3 892 000	3 765 000	3 681 000	4 145 000
Spain	3 973 000	3 645 000	4 036 000	4 160 000	3 396 000
Sweden	3 815 000	3 816 000	3 992 000	3 844 000	3 701 000
Switzerland	*80 000	*80 000	*80 000	*80 000	*80 000
Turkey	5 003 000	5 693 764	5 835 889	5 398 500	2 846 280
Ukraine	27 634 000	29 574 000	31 000 000	31 700 000	32 900 000
United Kingdom	8 560 600	10 277 800	10 179 600	10 188 800	10 695 700
Algeria	959 000	1 026 200	692 800	791 400	1 093 000
Egypt	3 630 000	3 950 000	*4 000 000	4 000 000	4 200 000
Libya	1 161 000	1 336 000	1 586 000	1 700 000	1 670 000
Morocco	*15 000	*15 000	*15 000	*15 000	*15 000
South Africa	7 525 000	7 776 000	7 644 000	7 900 000	7 914 000
Tunisia	151 900	35 800	—	—	—
Zimbabwe	122 000	182 000	145 000	*145 000	42 000
Canada	8 849 000	9 058 000	9 919 000	8 865 000	8 864 000
Mexico	8 570 500	9 656 000	10 623 000	10 112 000	9 962 000
Trinidad & Tobago	2 316 300	2 275 000	2 336 500	2 055 300	2 071 500
USA	40 700 000	40 854 000	42 300 000	37 200 000	*39 300 000
Argentina	3 649 700	4 138 600	4 147 500	4 466 500	4 426 000
Brazil	30 055 000	32 449 000	34 558 000	33 884 000	32 452 000
Chile	963 900	987 800	1 137 000	1 100 000	1 121 000
Colombia	309 300	283 300	288 000	325 000	351 000
Paraguay	87 400	98 000	119 000	123 000	131 000
Peru	267 200	310 400	353 000	*350 000	306 000
Venezuela	6 844 370	6 645 700	7 825 000	8 900 000	8 451 000
Burma	*40 000	*40 000	*40 000	*40 000	*40 000
China	170 850 000	213 666 800	251 850 500	330 404 700	404 167 000
India	30 046 000	33 601 000	34 238 000	37 105 000	43 098 000
Indonesia	1 446 000	1 171 000	1 436 000	1 300 000	1 300 000
Iran (a)	7 182 000	8 328 619	8 545 732	*9 178 000	*8 900 000
Japan	80 979 161	82 090 744	82 974 493	83 058 130	84 270 419
Kazakhstan	4 008 947	4 136 820	4 283 142	3 582 198	3 393 000
Korea, Dem. P.R. of	*250 000	*250 000	*250 000	*250 000	*250 000
Korea, Republic of	26 570 000	27 314 000	27 555 998	27 919 911	28 317 680
Malaysia	1 060 000	1 600 000	1 710 000	1 300 000	1 500 000
Pakistan	*1 000 000	*1 000 000	*1 500 000	*1 500 000	*1 500 000
Qatar	752 000	776 000	830 000	815 382	876 885
Saudi Arabia	3 280 000	3 285 000	3 406 000	3 626 000	3 581 000
Taiwan	10 169 000	10 260 000	10 354 000	9 447 000	10 263 000
Vietnam	146 000	200 000	187 000	...	...

Production of pig iron

tonnes

Country	2002	2003	2004	2005	2006
Australia	7 430 000	8 557 000	6 428 000	6 657 000	6 433 000
New Zealand	617 000	700 000	719 000	651 000	665 000
World Total	654 500 000	718 900 000	772 300 000	841 700 000	925 800 000

Note(s):-

(1) The data in this table include sponge iron and direct reduced iron (DRI) , where these have been separately identified

(a) Years ended 20 March following that stated

Production of crude steel

tonnes

Country	2002	2003	2004	2005	2006
Albania	80 924	86 117	115 000	140 000	...
Austria	6 189 000	6 261 000	6 530 000	7 031 000	7 129 000
Azerbaijan	4 600	32 700	90 400	286 100	335 300
Belarus	1 607 000	1 572 868	1 920 019	2 075 523	2 181 000
Belgium	11 322 008	11 114 775	11 697 000	10 422 000	11 650 000
Bosnia & Herzegovina	70 000	95 000	75 000	289 000	490 000
Bulgaria	1 860 000	1 950 000	2 106 000	1 940 000	2 100 000
Croatia	33 851	43 380	85 947	73 640	80 516
Czech Republic	6 511 970	6 783 000	7 033 000	6 189 000	6 862 000
Denmark	392 000	—	—	—	—
Finland	4 002 914	4 766 203	4 832 427	4 738 446	5 053 714
France	20 258 473	19 757 864	20 770 252	19 480 777	19 852 025
Germany	45 015 000	44 809 000	46 377 000	44 524 000	47 224 000
Greece	1 835 000	1 701 000	1 967 000	2 266 000	2 416 000
Hungary	2 138 146	2 044 526	1 944 017	2 004 250	1 992 000
Italy	26 302 000	27 058 000	28 603 000	29 349 000	31 624 000
Latvia	507 000	546 000	550 000	550 000	550 000
Luxembourg	2 736 000	2 675 000	2 684 000	2 194 000	2 802 000
Macedonia	261 398	306 635	319 873	321 170	326 484
Moldova	514 000	850 000	1 011 000	1 016 000	784 000
Montenegro	—	—	—	—	193 165
Netherlands	6 117 000	6 561 000	6 848 000	6 919 000	6 372 000
Norway	698 000	703 000	725 000	705 000	684 000
Poland	8 367 434	9 107 384	10 578 482	8 335 898	9 991 638
Portugal	894 000	1 000 000	1 400 000	1 400 000	1 400 000
Romania	5 490 434	5 692 496	6 076 600	5 631 566	6 263 000
Russia	59 882 574	62 839 334	65 582 851	66 146 000	69 307 877
Serbia	—	—	—	—	1 644 000
Serbia and Montenegro	595 547	722 376	1 167 000	1 292 000	—
Slovakia	4 275 470	4 588 000	4 454 000	4 485 000	5 093 000
Slovenia	481 000	541 000	566 000	583 000	627 000
Spain	16 408 000	16 407 000	17 700 000	17 826 000	18 391 000
Sweden	5 753 300	5 707 300	5 978 100	5 725 700	5 466 100
Switzerland	*1 000 000	*1 000 000	*1 000 000	1 158 000	1 252 000
Turkey	16 045 522	17 644 020	19 868 118	20 961 240	23 307 523
Ukraine	34 050 000	36 922 000	38 738 000	38 641 000	27 337 000
United Kingdom	11 527 600	13 128 500	13 765 700	13 238 900	13 904 600
Algeria	1 091 000	1 051 000	1 014 000	1 007 000	1 158 000
Egypt	4 316 000	4 398 000	4 810 000	5 603 000	*5 720 000
Libya	886 000	1 007 000	1 026 000	1 255 000	*1 158 000
Morocco	...	...	...	205 000	314 000
Nigeria	...	...	40 000	100 000	100 000
South Africa	9 095 000	9 481 000	9 500 000	9 494 000	9 721 000
Tunisia	200 500	85 600	69 900	65 700	67 700
Zimbabwe	105 000	152 000	135 000	107 000	23 000

Production of crude steel

tonnes

Country	2002	2003	2004	2005	2006
Canada	15 906 747	15 831 473	16 428 000	15 327 000	15 423 000
Cuba	264 100	210 000	193 151	245 076	257 200
Dominican Republic	60 956	*61 000	*61 000	*61 000	*61 000
El Salvador	48 832	56 900	60 000	48 000	74 000
Guatemala	216 000	226 000	232 000	207 000	292 000
Mexico	14 010 000	15 178 000	17 100 000	16 195 000	16 294 000
Trinidad & Tobago	816 900	896 000	789 800	712 000	673 000
USA	91 588 000	93 677 000	99 681 000	94 897 000	98 539 000
Argentina	4 363 367	5 033 200	5 125 200	5 382 000	5 533 000
Brazil	29 604 000	31 147 000	32 909 000	31 610 000	30 901 000
Chile	1 279 549	1 377 400	1 579 000	1 541 000	1 557 000
Colombia	662 859	668 400	806 000	1 007 000	1 058 000
Ecuador	67 233	79 800	72 000	83 000	140 000
Paraguay	79 984	91 000	115 000	101 000	126 000
Peru	611 363	668 400	726 000	790 000	885 000
Uruguay	34 400	40 500	58 000	64 000	47 000
Venezuela	4 163 855	3 930 300	4 561 000	4 907 000	4 745 000
China	182 370 000	222 336 000	272 797 900	349 361 500	422 660 300
Hong Kong	*100 000	*100 000	*100 000	*100 000	*100 000
India	28 814 000	31 779 000	32 626 000	38 098 000	44 622 000
Indonesia	2 459 928	2 042 233	3 681 865	3 675 442	3 756 347
Iran (a)	7 477 086	7 990 971	8 989 640	9 404 000	*9 789 000
Israel	*150 000	*150 000	*280 000	*300 000	*300 000
Japan	107 745 000	110 510 520	112 717 664	112 471 374	116 226 201
Jordan	134 000	*135 000	*140 000	150 000	150 000
Kazakhstan	4 866 000	5 069 400	5 371 698	4 476 642	4 208 000
Korea, Dem. P.R. of	*300 000	*300 000	*300 000	*300 000	*300 000
Korea, Republic of	45 389 834	46 309 629	47 520 871	47 820 037	48 433 000
Kuwait	—	*100 000	*200 000	*450 000	*500 000
Malaysia	4 721 800	3 960 000	5 698 000	5 300 000	5 500 000
Pakistan	*500 000	*500 000	*500 000	*500 000	*500 000
Philippines	550 000	500 000	400 000	470 000	558 000
Qatar	1 027 000	1 055 000	1 089 000	1 057 000	1 039 220
Saudi Arabia	3 570 000	3 944 000	3 902 000	4 186 000	3 976 000
Singapore	545 000	561 000	610 000	572 000	607 000
Syria	*70 000	*70 000	*70 000	*70 000	*70 000
Taiwan	18 226 044	18 828 323	19 592 755	18 563 247	19 974 997
Thailand	2 538 000	3 551 000	4 533 000	5 161 000	5 211 200
United Arab Emirates	*90 000	*90 000	*90 000	*90 000	*90 000
Uzbekistan	450 000	499 000	602 000	595 000	730 000
Vietnam	408 196	543 006	658 467	656 734	*700 000
Australia	8 874 000	9 678 000	8 353 000	7 788 000	7 880 000
New Zealand	765 000	853 000	885 000	889 000	823 000
World Total	905 000 000	972 000 000	1 062 000 000	1 131 000 000	1 228 000 000

Note(s):-

- (1) Unless otherwise indicated, these figures include production from scrap
- (2) Small amounts of steel are believed to be produced in Azerbaijan, Burma, DR Congo, Estonia, Ghana, Kenya, Mauritania, Morocco, Sri Lanka and Uganda

(a) Years ended 20 March following that stated

Production of ferro-alloys

tonnes

Country	2002	2003	2004	2005	2006
Albania					
Ferro-chrome	22 800	37 800	47 700	35 780	17 040
Austria					
Ferro-molybdenum	4 930	4 400	4 700	5 000	5 000
Ferro-nickel	2 150	2 000	1 900	2 500	2 500
Ferro-vanadium	5 500	5 300	5 800	6 250	6 250
Belgium					
Ferro-vanadium	1 492	...	...	...	...
Bulgaria					
Ferro-silicon	*8 000	*8 000	*8 000	*8 000	*8 000
Czech Republic					
Ferro-vanadium	*3 000	*3 000	*3 500	*2 700	*2 800
Finland					
Ferro-chrome	248 000	250 000	264 492	234 881	243 350
France					
Ferro-manganese & spiegeleisen	416 569	*300 000	*106 000	109 111	139 533
Ferro-silico-manganese	66 215	*107 000	*64 000	*65 000	...
Ferro-silicon	*100 000	*100 000	*100 000	*100 000	*100 000
Silicon metal	84 768	*85 000	*85 000	*85 000	*85 000
Georgia					
Ferro-manganese	4 211	12 425	12 821	13 945	5 130
Ferro-silico-manganese	30 432	50 932	93 830	109 414	116 945
Germany					
Ferro-chrome	20 018	18 318	24 857	22 672	26 710
Other ferro-alloys	*30 000	*30 000	*30 000	*30 000	*30 000
Silicon metal	25 257	27 870	28 773	29 349	29 865
Greece					
Ferro-nickel	96 000	90 000	91 000	96 000	89 000
Iceland					
Ferro-silicon	118 810	117 171	119 389	114 844	113 798
Italy					
Ferro-manganese	*40 000	25 000	38 000	32 000	13 000
Ferro-silico-manganese	*100 000	*100 000	*100 000	*100 000	96 600
Macedonia					
Ferro-nickel	5 135	5 629	5 313	8 141	10 942
Ferro-silicon	—	49 905	66 769	71 249	59 023
Norway					
Ferro-chrome	61 100	—	—	—	—
Ferro-manganese	126 960	*130 000	*130 000	*130 000	*130 000
Ferro-silico-manganese	252 723	*250 000	*260 000	*290 000	*310 000
Ferro-silicon	359 944	...	389 599	...	...
Other ferro-alloys	48 500	*50 000	*60 000	*60 000	*60 000
Silicon metal	152 981	*150 000	193 566	178 572	*150 000
Poland					
Ferro-chrome	106	188	—	—	—
Ferro-manganese	602	979	46 898	7 782	4 089
Ferro-silico-manganese	7 500	5 000	29 600	10 242	3 310
Ferro-silicon	41 759	92 687	83 552	65 118	13 034
Other ferro-alloys	4 200	—	1 419	3 663	4 848
Romania					
Ferro-manganese	—	—	191	18 625	3 224
Ferro-silico-manganese	84 720	141 899	194 754	100 957	53 076
Russia					
Spiegeleisen	*7 000	*7 000	*7 000	*7 000	*7 000
Ferro-chrome	231 790	351 729	453 639	*511 600	500 837
Ferro-silico-chrome	55 134	63 558	83 372	74 150	92 404
Ferro-manganese	*105 000	*101 000	*108 000	*108 000	*108 000
Ferro-nickel	*45 000	23 500	28 700	24 100	*24 000
Ferro-silicon	707 000	702 000	720 000	*742 000	*740 000
Other ferro-alloys	*30 000	*30 000	*36 000	*34 900	*35 000
Silicon metal	*40 000	*45 000	*45 000	*45 000	*45 000
Slovakia					
Ferro-chrome	5 695	1 924	1 784	867	19
Ferro-silico-manganese	62 084	52 733	64 862	47 843	...
Ferro-silicon	35 920	41 539	34 684	16 512	...
Other ferro-alloys	24 657	44 589	68 096	48 161	...

Production of ferro-alloys

tonnes

Country	2002	2003	2004	2005	2006
Slovenia					
Ferro-silicon	*9 000	*12 000	*18 000	*11 000	*8 000
Spain					
Ferro-manganese	33 218	*35 000	*35 000	*35 000	*35 000
Ferro-silico-manganese	103 494	*100 000	*100 000	*100 000	*100 000
Ferro-silicon	56 994	*60 000	*60 000	*60 000	*60 000
Silicon metal	26 071	*25 000	*25 000	*25 000	*25 000
Sweden					
Ferro-chrome	118 800	106 100	127 300	127 500	136 400
Ferro-silicon	21 500	17 100	18 500	9 800	4 600
Turkey					
Ferro-chrome	11 200	35 393	33 686	26 043	67 975
Ferro-silico-chrome	7 245	6 805	5 526	6 695	7 310
Ukraine					
Spiegeleisen	*5 000	*5 000	*5 000	*5 000	*5 000
Ferro-manganese	*350 000	383 200	498 800	359 000	373 000
Ferro-silico-manganese	732 592	991 600	1 088 600	1 045 900	1 168 000
Ferro-nickel	31 000	52 000	78 000	*78 000	*78 000
Ferro-silicon	250 617	286 200	324 700	227 500	168 000
Other ferro-alloys	...	...	...	87 985	127 505
Egypt					
Ferro-silicon (c)	*55 000	*55 000	*55 000	*55 000	*55 000
Other ferro-alloys (c)	16 679	*20 000	*20 000	*20 000	*20 000
South Africa					
Ferro-chrome	2 351 122	2 813 000	3 031 515	2 811 836	2 893 400
Ferro-manganese	618 954	607 362	611 914	570 574	*570 000
Ferro-silico-manganese	315 802	313 152	373 928	275 324	*275 000
Ferro-silicon	141 700	135 300	140 600	127 000	*127 000
Ferro-vanadium	*11 000	*18 000	*23 000	*23 000	*23 000
Silicon metal	42 500	48 500	50 500	53 500	*54 000
Zimbabwe					
Ferro-chrome	258 164	261 095	218 065	218 143	200 673
Ferro-silico-chrome	—	—	987	4 882	1 024
Canada					
Ferro-niobium	5 100	5 000	*5 300	*5 000	*5 000
Ferro-silicon	*70 000	*70 000	*70 000	*70 000	*70 000
Silicon metal	*30 000	*30 000	*30 000	*30 000	*30 000
Dominican Republic					
Ferro-nickel	59 629	69 545	75 764	73 962	76 659
Mexico					
Ferro-manganese	38 532	55 903	72 471	89 642	62 485
Ferro-silico-manganese	73 263	81 223	103 206	104 780	97 457
USA					
Ferro-silicon	181 832	147 964	170 592	209 000	253 000
Silicon metal	108 494	133 680	144 489	148 000	*148 000
Argentina					
Ferro-silico-manganese	*5 000	*5 000	*5 000	*5 000	*5 000
Ferro-silicon	2 700	2 700	2 700	*2 700	*2 700
Other ferro-alloys	17 289	*15 000	15 000	*15 000	*15 000
Silicon metal	*8 000	*8 000	*8 000	*8 000	*8 000
Brazil					
Ferro-chrome	159 658	196 032	204 626	185 533	158 585
Ferro-silico-chrome	10 522	8 151	11 560	16 683	8 221
Ferro-silico-magnesium	14 552	14 040	37 031	...	...
Ferro-manganese	156 435	176 735	179 971	*185 000	*185 000
Ferro-silico-manganese	182 731	261 658	285 629	*285 000	*280 000
Ferro-nickel	19 874	19 378	20 338	21 200	27 600
Ferro-niobium	36 450	37 303	35 863	38 819	...
Ferro-silicon	145 910	156 824	177 245	177 000	128 000
Other ferro-alloys	25 300	38 559	45 868	...	...
Silicon metal	133 390	180 937	219 813	187 950	186 000
Chile					
Ferro-molybdenum	1 784	4 423	5 762	...	...
Ferro-silicon	*1 100	...	...	...	...

Production of ferro-alloys

tonnes

Country	2002	2003	2004	2005	2006
Colombia					
Ferro-nickel	101 000	108 100	111 700	122 700	118 900
Venezuela					
Ferro-silico-manganese	36 974	30 632	*35 000	*35 000	*35 000
Ferro-nickel	*57 200	75 278	67 796	*56 000	*56 000
Ferro-silicon	87 528	90 534	*92 000	*92 000	*92 000
Bhutan					
Ferro-silicon	*21 000	*21 000	21 147	*20 000	*20 000
China					
Ferro-chrome	332 011	534 842	635 000	854 000	1 050 000
Ferro-silico-chrome	43 492	97 552	105 000	48 000	75 000
Other ferro-alloys	4 465 000	5 738 000	8 180 000	9 698 000	*12 000 000
Silicon metal	*500 000	*600 000	*660 000	*650 000	*730 000
India					
Ferro-aluminium (b)	2 000	5 169	5 917	7 214	9 947
Ferro-chrome (b)	380 528	525 824	594 994	662 297	801 368
Ferro-silico-magnesium (b)	6 369	6 289	7 092	11 171	11 387
Ferro-manganese (b)	236 676	248 388	270 234	273 057	296 726
Ferro-silico-manganese (b)	304 212	380 316	498 047	596 372	782 962
Ferro-molybdenum (b)	3 114	2 949	2 864	2 827	3 120
Ferro-silicon (b)	81 955	68 844	99 296	90 652	92 632
Ferro-vanadium (b)	914	769	826	877	1 139
Other ferro-alloys (b)	366	418	723	960	2 170
Indonesia					
Ferro-manganese	*12 000	*12 000	*12 000	*12 000	*12 000
Ferro-silico-manganese	*7 000	*7 000	*7 000	*4 000	*4 000
Ferro-nickel	42 306	43 894	39 538	20 036	—
Iran					
Ferro-chrome (a)	2 300	8 000	7 750	*8 000	*8 000
Ferro-silicon (a)	41 663	40 297	50 140	*50 000	*50 000
Japan					
Ferro-chrome	91 937	19 427	13 472	12 367	13 056
Ferro-manganese	356 717	371 831	437 389	448 616	406 162
Ferro-silico-manganese	74 171	61 618	73 041	94 725	59 424
Ferro-molybdenum	2 375	2 691	3 323	4 019	4 229
Ferro-nickel	370 973	369 099	374 213	391 074	335 884
Ferro-tungsten	9	12	—	—	—
Ferro-vanadium	3 592	3 491	2 178	2 360	2 042
Other ferro-alloys	6 376	3 813	7 321	10 057	13 123
Kazakhstan					
Ferro-chrome	835 743	993 007	1 080 993	1 156 167	*1 170 000
Ferro-silico-chrome	108 028	98 134	104 800	97 870	*100 000
Ferro-silico-manganese	163 725	178 924	155 324	170 001	*170 000
Ferro-silicon	126 968	127 161	103 580	104 186	*104 000
Other ferro-alloys	986	...	—	—	...
Korea, Dem. P.R. of					
Ferro-alloys	*10 000	*10 000	*10 000	*10 000	*10 000
Korea, Republic of					
Ferro-manganese	137 000	141 000	165 525	124 000	169 202
Ferro-silico-manganese	94 000	90 942	82 917	74 000	94 119
Australia					
Ferro-manganese (c)	73 523	104 022	133 985	166 513	114 715
Ferro-silico-manganese (c)	138 938	130 568	116 630	96 575	103 207
Silicon metal	*30 000	*30 000	*30 000	*30 000	*30 000
New Caledonia					
Ferro-nickel	162 973	167 208	151 296	172 067	180 724

Note(s):-

(a) Years ended 20 March following that stated

(b) Years ended 31 March following that stated

(c) Years ended 30 June of that stated

Production of kaolin

tonnes

Country	2002	2003	2004	2005	2006
Albania	...	...	300 000	310 000	...
Austria	21 212	15 034	16 345	55 508	51 900
Belgium	*300 000	*300 000	*300 000	*300 000	*300 000
Bosnia & Herzegovina	6 500	13 178	13 500	14 500	*14 500
Bulgaria	*150 000	*120 000	*190 000	*200 000	*240 000
Czech Republic (h)	577 000	591 000	596 000	649 000	673 000
France	339 000	335 000	316 000	293 000	*300 000
Germany (g)	740 821	738 123	*740 000	*750 000	*750 000
Greece	57 885	59 680	53 438	49 912	*50 000
Hungary	...	...	3 300	1 300	1 350
Italy	174 990	224 755	246 608	183 804	...
Poland (k)	89 372	106 761	130 596	159 207	148 579
Portugal	147 448	169 669	152 077	164 072	167 298
Romania	22 517	25 741	22 338	26 772	10 790
Russia	*45 000	*45 000	*45 000	*45 000	*45 000
Serbia	—	—	—	—	...
Serbia and Montenegro	95 622	99 460	108 000	135 000	—
Slovakia	24 600	24 800	89 424	34 830	63 210
Spain (k)	419 483	427 193	437 990	456 000	450 000
Turkey	372 344	370 455	536 008	615 271	*600 000
Ukraine (h)	*170 000	169 900	202 300	216 600	251 000
United Kingdom (a) (l)	2 162 815	2 097 137	1 944 955	1 910 874	1 762 328
Algeria	9 505	19 258	27 700	34 386	32 523
Egypt	260 000	*260 000	249 761	*250 000	*250 000
Eritrea	120	140	50	518	118
Ethiopia (b)	3 534	3 088	4 251	3 726	1 641
Kenya	*700	*700	*700	*700	*700
Nigeria	52 352	57 587	*57 000	*57 000	*57 000
South Africa	91 456	86 365	81 901	59 356	51 602
Cuba	2 400	2 900	4 128	3 457	1 700
Mexico	745 498	798 407	654 711	877 147	961 800
USA (e)	8 010 000	7 680 000	7 760 000	7 800 000	*7 740 000
Argentina	13 865	19 219	39 072	54 903	49 619
Brazil (h)	1 757 488	2 081 000	2 381 000	2 410 000	2 455 000
Chile	6 164	11 500	51 769	15 183	44 642
Ecuador	8 483	11 884	5 646	5 928	*6 000
Paraguay	*66 700	*66 600	*66 600	*66 600	66 000
Peru	1 934	2 653	2 720	1 200	1 022
Venezuela	*10 000	*10 000	*10 000	*10 000	*10 000
Bangladesh (d)	*8 000	9 630	13 113	13 738	19 766
China	2 600 000	2 700 000	3 120 000	3 120 000	3 270 000
India (c) (i)	204 694	209 920	220 262	238 759	*245 000
Indonesia	*15 000	*15 000	*15 000	*15 000	*15 000
Iran (j)	592 803	556 003	596 886	531 109	*530 000
Japan	11 602	12 223	11 553	*12 000	*12 000
Jordan	162 786	179 153	216 566	168 264	112 787
Kazakhstan	*20 000	*20 000	—	—	...
Korea, Republic of	1 054 543	1 042 018	936 537	1 074 936	958 836
Malaysia	323 916	425 942	326 928	494 511	341 223
Pakistan (d)	55 584	39 575	25 204	37 732	53 051
Philippines	*5 000	1 860	3 240	6 927	...
Saudi Arabia	7 920	8 100	2 135	1 489	2 100
Sri Lanka	8 613	9 073	16 233	9 914	10 914
Taiwan	18 403	22 448	35 001	9 423	4 107
Thailand (h)	130 282	185 512	200 671	156 853	157 900
Uzbekistan (i)	*150 000	*150 000	*150 000	*150 000	*150 000
Vietnam	521 700	644 200	741 200	780 000	*800 000

Production of kaolin

tonnes

Country	2002	2003	2004	2005	2006
Australia (d) (f)	228 000	280 000	285 543	231 611	182 304
New Zealand	17 250	14 770	15 250	15 750	14 864
World Total	23 400 000	23 900 000	24 800 000	25 300 000	25 100 000

Note(s):-

(1) In addition to the countries listed Denmark is believed to produce kaolin

- (a) Sales
- (b) Years ended 7 July of that stated
- (c) Years ended 31 March following that stated
- (d) Years ended 30 June of that stated
- (e) Sold or used by producers
- (f) Excluding New South Wales
- (g) Washed and dried
- (h) Beneficiated
- (i) Beneficiated; excludes directly used natural kaolin
- (j) Years ended 20 March following that stated
- (k) Washed
- (l) Dry weight

LEAD

Characteristics

Lead is a dense (11.34 g/cm³), bluish-white metal with little mechanical strength and virtually no elasticity. It is extremely soft and highly malleable, with a low melting point (327.4°C). When freshly cut the surface has a metallic lustre, but this quickly tarnishes to dull grey when exposed to air due to oxidation. It has poor electrical conductivity compared to other metals. Lead is a potent neurotoxin that accumulates in soft tissues and bone over time, and this has led to increasing restriction in its usage in recent years.

Lead is rarely found as native (free) metal, but is usually extracted from sulphide ores in which the most common lead mineral is galena (lead sulphide; PbS). It is usually found in association with other sulphide minerals also used as ores, most frequently those of zinc and copper, but also precious metals. Silver commonly occurs in galena both in solid solution and as a sulphide phase. Galena is the chief source of commercial silver output. Other economic lead ore minerals include cerussite (lead carbonate; PbCO₃) and anglesite (lead sulphate; PbSO₄), commonly found as weathering products overlying sulphide ore bodies. In terms of mine output lead is almost always a co-product with other base metals

Lead is obtained from galena by a process called smelting. This involves roasting the ore to remove the sulphur and to obtain lead oxide, which is then reacted with coke in a furnace. The resulting lead bullion contains many impurities such as silver and gold (hence the name bullion) as well as antimony, arsenic, copper, tin and zinc. These impurities are then removed by various refining steps to obtain pure lead (Lead Development Association International, 2008).

World reserves of lead are 79 million tonnes (Mt), of which Australia holds 24 Mt, China 11 Mt and USA 7.7 Mt.

Uses

Current global use of lead (Ellis, 2007):

- lead-acid batteries 77%
- pigments 8%
- rolled extrusions 6%
- alloys (including casting) 3%
- shot/ammunition 2%
- cable sheathing 1%
- miscellaneous 3%

The most important use of lead is in lead-acid batteries which provide ancillary electrical power (chiefly for starting) in virtually all road vehicles and also in electrically-driven vehicles. They also provide emergency power in the event of power failure. Lead's softness and low melting point make lead very easy to work hence it has a long history of exploitation. Its high resistance to corrosion makes it ideal for weather-proofing buildings and for equipment used in the manufacture of acids. Lead's high density means that it absorbs radiation and noise. It is used as radiation shielding in medical applications and the nuclear industry, and in sound-proofing. Lead chromate (yellow) and lead molybdate (red/orange) are used as colouring pigments for ceramic glazes, plastics and to a lesser extent under current legislation, paints e.g. in road paint. Lead oxide (PbO) in glass reduces the transmission of radiation, and glasses for VDU equipment may contain up to 28 per cent PbO (Lead Development Association International, 2008). Other minor uses include weights and molten lead is used as a coolant in fast reactors.

Owing to its toxicity, lead use has become more strictly regulated and restricted over the last 30 years. Initially, the change was due to the requirement of US lead consumers to comply with environmental regulations which significantly reduced or eliminated the use of lead in non-battery products, including as a petrol additive, in paints, solders, and water systems. Lead use is being further curtailed by the European Union's RoHS Directive which came into force on 1 July 2006. Lead may still be found in harmful quantities in stoneware, vinyl (such as that used for tubing and the insulation of electrical cords), and in brass manufactured in China. Throughout 2006–2007, many children's toys made in China were recalled due to lead in paint used to colour the product; e.g. the toy firm Mattel recalled 55 000 Chinese-made toys in the US after lead contamination fears (BBC News, 25 October 2007).

World production in 2006

Worldwide production of refined lead was eight million tonnes in 2006; a 19 per cent increase over 2005 production. Production increased steadily during the period 2002 to 2006, with an overall increase of 16 per cent, although levelling out in 2005. China is the top-producing country with 2.7 million tonnes in 2006. This represents a 14 per cent increase on 2005 and a 106 per cent increase since 2002. The USA was the second largest producer with 1.3 million tonnes and Germany, third, with production of 0.3 million tonnes.

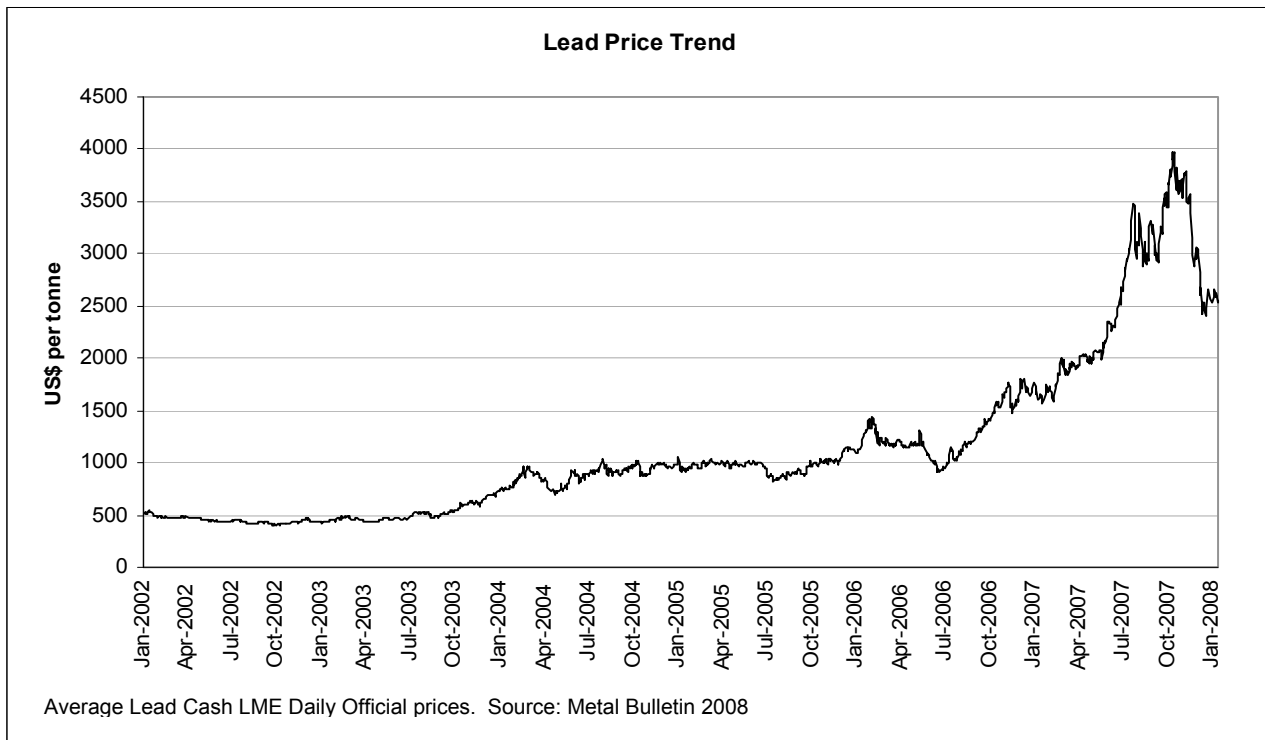
The reliance on scrap metal recycling is increasing, and in 2006 about 50 per cent of refined lead was produced this way. In the 'western' world today more lead is produced by recycling than by mining (Lead Development Association International, 2008). Primary (mined) lead production is dominated by China, Australia and the USA, which together account for more than half of the total.

Prices

Lead prices started to increase in 2006 after a period of relative price stability at around US\$500 per tonne through the 1990s up until 2003. Prices had doubled by mid-2006 before the rate of increase began to escalate more dramatically. In 2007 the London Metal Exchange (LME) official price for lead set record highs, reaching an all-time high of US\$3980 per tonne on 15 October as a result of concerns about tight supplies and expectation of continuing growth in demand. At the beginning of October, LME stocks stood at just 22 000 tonnes sufficient for less than one day's global consumption, and the squeeze on supplies available for immediate delivery showed no signs of easing (Ellis, 2007).

Prices rose dramatically in response to the suspension of production at Toronto-based Ivernia Inc.'s Magellan Mine in Western Australia in March 2007 (Ellis, 2007). This mine remains the world's only pure primary lead mine. Output was suspended after contamination at the Port of Esperance, where Magellan routes all its exports, when thousands of seabirds died from lead poisoning. The company was officially blamed for the contamination in September 2007 (Parliament of Western Australia, 2007).

Supplies to the world market were further disrupted by an explosion at Doe Run Resources Corporation's Herculaneum smelter in Missouri, USA, which was reported to have halved production (Mining Journal, 20 July 2007).



China remains the single biggest influence on the world lead market. The Chinese Government removed the 13 per cent export rebate on lead metal in September 2006, and subsequently imposed a 10 per cent export tax on refined lead on 1 June 2007. Chinese exports declined partly due to these changes in taxation. But also because of burgeoning domestic demand for lead-acid battery production and production at Chinese smelters was cut due to lead concentrate supply problems. China is now a net importer of lead concentrate which further fuelled the price rise. In July, Macquarie Bank speculated that smelter output cuts had led to a global panic which caused the observed price rises (Mining Journal, 6 July 2007).

By September 2007, China's exports of lead were at their lowest level for seven months, 74 per cent down, and exports for the first nine months of 2007 were half the level of the equivalent period in 2006. Overall, China's reported production was down almost 11 per cent, contributing to a worldwide shortage (Hinde, 2007). By December China's lead exports continued to fall by double-digit rates in December, according to the General Administration of Customs. Refined lead exports fell 77 per cent year-on-year to 13 152 tonnes in December. This took lead exports to 235 758 tonnes in 2007, a 56.1 per cent decline from the previous year. China's lead exports have continued to decline since a 10 per cent export tax was introduced last June.

September saw further rapid price increases, driven by increased buying in the wake of a fire at Xstrata's concentrator at their Mount Isa Mines in Queensland, Australia. The fire resulted in Xstrata losing up to 20 000 tonnes of lead concentrate production, which in itself is not that significant an amount, but again demonstrates how tight the market had become in the final quarter of 2007 (Meir, 2008).

The US Federal Reserve also cut interest rates by 50 basis points on 18 September¹, stimulating demand in the US and raising the price towards its maximum. The possibility of

recession in the US, an economy still some seven times greater than China, could still be the controlling factor on the long term commodity price (Meir, 2007).

In the final two months of 2007 lead prices saw a significant reduction (although stabilising during December) as stocks rose steadily, doubling from the low levels reported in October. Chinese refined lead exports in November also rose to their highest level since June. With the prospect of exports resuming from Ivernia's Magellan Mine prices remain are likely to remain depressed. This period also saw declines in the prices of other base metals following a period of sharp decline in physical premiums² beginning in May 2007 although this had stabilised across the USA, Europe and Japan over the last quarter of 2007 (International Mining online, January 2008). Given the strong increases in freight rates over the previous 12 months (which saw many more than double), the fall in premiums could have a significant impact on both producers and traders.

Analysts now predict prices between US\$2000 and US\$2600 per tonne in the early part of 2008 (Meir, 2008).

Industry events in 2007

The year saw increases in both supply of lead to the market and demand, above the long-term trend. Lead price rises have also driven mining companies to expand their exploration and production activities.

China became an even more influential force on the world market as the world's premier lead producer and consumer. In 2006, China produced 2.4 million tonnes of refined lead, of which a fifth was exported. However, exports dropped during 2007 both due to increased domestic demand and changes in taxation. Increasing levels of Chinese investment and ownership of mines especially in Asia, Africa and Latin

¹ <http://www.federalreserve.gov/fomc/fundsrate.htm>

² The physical metals premium is the price that metals purchasers are required to pay (freight, insurance, warehousing and logistical costs etc. in addition to the LME price) to receive delivery of their purchase at a specified location.

America has not been without controversy, and has led to problems over employment terms and conditions. Exploitation of the Duddar lead-zinc deposit in Pakistan by China's Metallurgical Group Corp. is also expected to yield around 10 000 tonnes of lead concentrate (Ellis, 2007).

Australia remains a major influence in the world market. It is also expected to show the most significant rises in lead production after China, with Xstrata Plc continuing production at Mount Isa and Broken Hill and deciding to proceed with its Handlebar Hill zinc-lead project north of Mount Isa, Queensland (Xstrata Plc, 2007). Teck Comino also restarted production at Lennard Shelf. Perilya Ltd is also developing their Potosi mine at Broken Hill (Perilya Ltd., 2007).

In Europe, the Lundin Mining Corp. commenced production at its Aljustrel zinc-lead-silver mine in southern Portugal, achieving its zinc concentrate production on 16 December 2007. Lundin also intends to bring forward the production of zinc and lead concentrate from the Feitais orebody by twelve months — this was originally planned for the second half of 2009 (Lundin Mining Corporation, 2007).

In Canada the Acadian Mining Corporation commenced production at Scotia Mine, an open pit zinc-lead mine at Gays River, Nova Scotia, in May 2007. The mine is expected to produce 10 000 tonnes per year of high grade lead concentrate (Acadian Mining Corp., 2008).

Apex Silver Mines Limited reported the first shipment of concentrates from the San Cristobal mine in Bolivia out of the port of Mejillones, Chile on 22 September. This initial shipment of approximately 3500 tonnes of lead, zinc and silver bulk concentrate was produced during the commissioning and start-up of the plant (Apex Silver Mines Ltd, 2007).

Output from Peru also increased, and Gold Hawk Resources Inc. commissioned its Coricancha Mine and processing facility, with the first lead and zinc concentrates being produced in February 2007 (Gold Hawk Resources Inc., 2007).

In addition to new producers coming on stream, output of lead concentrate should also rise in 2008 as export recommences from Ivernia Inc.'s Magellan Mine, Western Australia. Agreements have been reached to allow exports of containerised shipments via an alternative route, the Port of Freemantle (Ivernia Inc., 2008).

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Mine production of lead

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Bulgaria	19 800	19 950	*19 400	*18 500	*16 000
Greece	29 300	2 000	—	3 000	12 400
Irish Republic	41 700	50 300	63 800	72 200	61 800
Italy	3 200	2 700	800	*800	*800
Macedonia	3 528	—	—	—	15 582
Poland	56 600	54 700	52 700	50 900	50 000
Romania	17 500	15 747	18 297	11 610	7 500
Russia	19 000	24 000	23 200	36 400	34 000
Serbia	—	—	—	—	7 000
Serbia and Montenegro	4 355	4 567	*5 300	2 000	—
Spain	6 171	1 765	—	—	—
Sweden	42 954	50 962	54 347	60 445	55 644
Turkey	17 277	17 483	18 792	11 341	18 000
United Kingdom	*700	*700	*500	*500	*500
Algeria	690	—	—	—	—
Morocco	62 417	39 387	44 200	53 000	*55 000
Namibia	12 088	16 112	14 338	14 320	11 830
South Africa	49 444	39 941	37 485	42 159	48 273
Tunisia	5 081	5 100	5 332	8 407	1 000
Canada	97 178	81 264	76 730	79 254	82 393
Honduras	8 128	9 014	8 877	10 488	11 775
Mexico	138 707	139 348	118 484	134 388	*134 000
USA	440 100	448 700	430 000	426 400	452 900
Argentina	12 011	12 079	9 551	10 683	12 778
Bolivia	9 268	9 353	10 252	11 231	11 955
Brazil	9 253	10 652	14 737	16 063	16 007
Chile	2 895	1 697	2 286	878	672
Peru	298 487	308 874	306 211	319 345	313 325
Burma	*2 000	*2 000	*2 000	*2 000	*2 000
China	640 700	954 600	997 200	1 142 000	1 251 000
India (a)	37 800	46 700	52 200	62 800	69 000
Iran (b)	19 000	20 000	21 000	21 179	24 000
Japan	5 758	5 700	5 500	3 400	800
Kazakhstan	45 500	38 200	44 135	45 370	62 000
Korea, Dem. P.R. of	*10 000	*20 000	*20 000	*20 000	*20 000
Korea, Republic of	28	—	40	50	17
Tajikistan	—	—	—	407	—
Thailand	2 600	—	—	—	—
Vietnam	*1 100	*1 100	*2 800	*3 300	*3 500
Australia	694 000	688 000	674 000	767 000	668 000
World Total	2 900 000	3 100 000	3 200 000	3 500 000	3 500 000

Note(s):-

(a) Years ended 31 March following that stated

(b) Years ended 20 March following that stated

Production of refined lead

tonnes

Country	2002	2003	2004	2005	2006
Austria	*23 000	*20 000	*26 000	*24 000	*22 000
Belgium	88 000	65 000	62 000	97 200	84 000
Bulgaria	67 500	74 000	69 000	93 500	84 300
Czech Republic	*29 000	*26 000	*25 000	26 000	25 000
Estonia	—	—	3 000	*7 000	*7 000
France	203 400	91 000	89 000	*90 000	*88 000
Germany	379 905	356 900	359 200	341 700	321 500
Greece	*6 000	*6 000	*6 000	*6 000	*6 000
Irish Republic	6 600	7 800	19 600	22 500	21 700
Italy	196 000	214 100	201 600	211 000	190 500
Macedonia	11 934	6 357	3 591	—	—
Netherlands	18 000	17 000	17 000	17 000	16 000
Poland	65 800	74 300	73 900	81 000	73 000
Portugal	*6 000	*6 000	*6 000	*6 000	*5 000
Romania	23 000	28 000	32 590	32 903	29 333
Russia	63 000	66 000	66 000	65 700	78 000
Serbia and Montenegro	200	493	800	—	—
Slovenia	15 400	15 000	*15 000	15 000	15 000
Spain	115 552	99 100	105 600	110 000	131 000
Sweden	63 451	73 340	73 548	72 600	71 000
Switzerland	8 700	9 600	9 300	9 600	*9 600
Turkey	*9 000	*9 000	*9 000	*9 000	*9 000
Ukraine	12 000	13 000	*15 000	61 400	56 300
United Kingdom	374 646	364 574	245 938	304 350	306 737
Algeria	6 000	*6 000	*6 000	*6 000	*6 000
Kenya	*1 000	*1 000	*1 000	*1 000	*1 000
Morocco	71 840	61 473	25 000	54 000	45 000
Nigeria	*5 000	*5 000	*5 000	*5 000	*5 000
South Africa	61 000	65 000	64 000	65 300	*67 000
Canada	251 560	223 434	241 169	230 237	250 464
Mexico	238 200	247 500	217 400	213 700	212 500
Trinidad & Tobago	*1 000	*1 000	*1 000	*1 000	*1 000
USA (b)	1 364 000	1 392 000	1 262 000	1 293 000	1 297 000
Argentina	43 600	41 311	49 111	45 607	49 064
Brazil (a)	50 000	128 610	137 121	104 904	142 653
Colombia	*9 000	*9 000	*9 000	*10 000	*10 000
Peru	119 588	112 289	118 970	122 079	120 311
Venezuela	*28 000	*32 000	*35 000	*35 000	*36 000
Burma	400	900	300	500	500
China	1 324 700	1 564 100	1 934 500	2 391 400	2 735 500
India	74 200	77 500	*51 000	*54 000	*100 000
Indonesia	17 000	18 000	20 000	18 000	18 000
Iran	39 000	54 000	54 000	71 000	75 000
Israel	22 000	*25 000	27 000	28 000	25 000
Japan	280 341	295 148	282 900	274 600	280 600
Kazakhstan	160 800	140 700	156 600	135 400	125 900
Korea, Dem. P.R. of	6 000	7 000	9 000	9 000	9 000
Korea, Republic of	243 000	220 000	229 000	257 000	240 000
Malaysia	40 000	57 000	54 000	55 000	55 000
Pakistan	*2 000	*2 000	*2 000	*2 000	*2 000
Philippines	*26 000	*27 000	*29 000	*30 000	*30 000
Saudi Arabia	17 000	25 000	32 000	36 000	38 000
Taiwan	55 000	56 000	56 000	55 000	54 000
Thailand	43 000	45 300	57 500	61 100	61 160
United Arab Emirates	2 000	2 000	2 000	*2 000	*2 000

Production of refined lead

tonnes

Country	2002	2003	2004	2005	2006
Australia	302 000	309 000	274 000	267 000	241 000
New Zealand	9 000	8 000	8 000	7 000	7 000
World Total	6 700 000	6 900 000	7 000 000	7 600 000	8 000 000

Note(s):-

(1) Figures relate to both primary and secondary refined lead and include the lead content of antimonial lead. Metal recovered from materials by remelting alone is excluded

- (a) Including scrap for direct use
- (b) Excluding Pb content of primary antimonial lead

Production of lithium minerals

tonnes

Country	2002	2003	2004	2005	2006
Portugal					
Lepidolite	16 325	24 606	28 696	26 185	28 497
Spain					
Lepidolite	6 800	6 333	3 226	4 000	6 000
Zimbabwe	29 320	12 131	13 710	37 499	...
Canada	*22 500	*22 500	*22 500	*22 500	*22 500
USA (a)	*1 500	*1 500	*1 500	*1 500	*1 500
Argentina (b) (c)	5 635	7 550	11 273	15 700	16 500
Brazil					
Spodumene	12 046	9 755	9 064	8 924	8 585
Chile (c)	35 242	41 667	43 971	43 595	50 035
China	*34 000	*35 000	*36 000	*37 000	*37 000
Australia					
Spodumene	79 085	124 410	118 451	173 635	222 101
World Total (Li content)	*12 300	*14 100	*15 200	*17 000	* 18 300

Note(s):-

(1) In addition to the countries listed, Russia also produces lithium minerals

- (a) Li content
- (b) Chloride
- (c) Carbonate

Production of magnesite

tonnes

Country	2002	2003	2004	2005	2006
Austria	728 235	766 525	715 459	693 754	769 188
Greece	553 700	542 800	552 300	471 000	463 277
Netherlands (c)	226 000	261 194	245 495	285 336	293 006
Poland	22 100	27 200	57 900	55 300	*56 000
Russia	2 600 000	2 600 000	*2 600 000	*2 600 000	*2 600 000
Serbia and Montenegro	25 247	17 488	—	—	—
Slovakia	929 630	1 640 900	965 900	920 100	941 100
Spain	637 024	517 030	567 504	556 129	*550 000
Turkey	3 044 440	3 224 278	3 732 952	2 372 206	2 088 033
South Africa	87 200	86 100	65 900	54 800	*55 000
Zimbabwe	2 546	822	749	864	939
Canada (b)	*165 000	*180 000	*180 000	*180 000	*180 000
Argentina	29 956	—	—	—	—
Brazil	302 230	306 444	366 174	386 759	323 902
Colombia	*10 500	*10 500	*10 500	*10 500	*10 500
China	11 000 000	12 000 000	13 310 000	15 440 000	13 640 000
India (e)	278 267	323 977	383 953	351 495	243 264
Iran (a)	69 683	87 795	88 194	94 850	*95 000
Korea, Dem. P.R. of	*1 200 000	*1 200 000	*1 000 000	*1 000 000	*1 000 000
Pakistan (d)	5 936	3 435	6 074	3 029	1 151
Philippines	3 604	3 799	3 201	2 413	...
Saudi Arabia	...	...	—	45 000	...
Australia	483 838	472 668	586 393	*627 000	*492 000
World Total	22 400 000	24 300 000	25 400 000	26 200 000	23 800 000

Note(s):-

(1) In addition to the countries listed, Bulgaria is believed to produce magnesite

- (a) Years ended 20 March following that stated
- (b) Officially described as magnesitic dolomite and brucite
- (c) Chloride produced from solution mining
- (d) Years ended 30 June of that stated
- (e) Years ended 31 March following that stated

Production of primary magnesium metal

tonnes

Country	2002	2003	2004	2005	2006
France	2 000	—	—	—	—
Norway	3 100	—	—	—	—
Russia	*35 000	*30 000	*35 000	*38 000	*35 000
Serbia	—	—	—	—	*500
Serbia and Montenegro	—	*500	*500	*500	—
Ukraine	—	—	—	2 900	12 000
Canada	*70 000	*50 000	*40 000	*45 000	*45 000
USA	20 000	10 000	*30 000	*40 000	*40 000
Brazil	4 500	4 000	3 000	3 000	5 000
China	235 000	341 800	442 400	467 600	525 600
India	*500	*200	*200	*200	*200
Israel	30 000	26 000	28 000	27 853	24 581
Kazakhstan (a)	17 858	14 164	18 000	20 000	21 000

Note(s):-

(a) Not marketed as metal but used in titanium production

Production of manganese ore

tonnes

Country	2002	2003	2004	2005	2006
Bulgaria	4	4 200	27 800	38 500	20 500
Georgia (b)	103 400	173 500	218 500	251 800	328 643
Hungary	43 000	48 000	49 000	50 000	50 000
Italy	867	763	714	632	...
Romania	59 148	72 931	79 130	72 000	70 910
Russia	...	44 400	44 400	*44 400	44 400
Turkey	20 000	18 000	13 751	4 751	...
Ukraine (b)	2 740 000	2 533 000	2 273 100	*2 000 000	*2 000 000
Egypt	...	...	...	22 971	*20 000
Gabon	1 856 000	2 000 000	2 459 170	2 752 987	2 978 972
Ghana	1 135 828	1 509 432	1 597 085	1 719 589	*1 800 000
Ivory Coast	—	—	—	*36 500	*73 500
Morocco	17 484	18 064	*16 500	*16 000	16 000
Namibia	—	—	—	7 320	18 918
South Africa					
Metallurgical	3 302 129	3 484 801	4 264 762	4 599 289	5 201 162
Chemical	19 516	15 837	17 194	12 810	12 176
Mexico	233 025	312 506	381 982	371 054	381 982
Brazil	2 529 000	2 544 000	3 143 000	3 200 000	3 128 000
Chile	12 195	19 641	25 801	39 786	37 169
China	*4 500 000	*4 600 000	*5 500 000	*6 000 000	*6 000 000
India (c)	1 678 372	1 776 153	2 386 396	2 003 474	2 092 000
Iran (a)	123 148	115 680	128 924	114 708	*115 000
Kazakhstan	1 834 500	2 361 000	2 318 100	2 207 700	*2 200 000
Malaysia	...	...	...	—	6 500
Thailand	—	—	4 550	88 500	1 000
Australia	2 190 000	2 555 000	3 401 000	3 829 000	4 567 000
World Total	22 400 000	24 200 000	28 400 000	29 500 000	31 200 000

Note(s):-

(1) In addition to the countries listed, Colombia, Cuba and Vietnam are believed to produce manganese ore

(a) Years ended 20 March following that stated

(b) Marketable

(c) Years ended 31 March following that stated

Production of mercury

kilograms

Country	2002	2003	2004	2005	2006
Finland	50 600	25 000	23 500	34 200	22 820
Russia	*50 000	*50 000	*50 000	*50 000	*50 000
Spain	726 139	745 260	—	—	—
Algeria	307 119	175 570	67 200	300	—
Morocco	*10 000	*10 000	*10 000	*10 000	*10 000
Mexico	*15 000	*15 000	*15 000	*15 000	*15 000
USA	*15 000	*15 000	*15 000	*15 000	*15 000
Chile (a)	*50 000	*50 000	*50 000	*50 000	*50 000
China	495 000	612 000	1 140 000	1 094 000	800 000
Kyrgyzstan	478 000	370 000	488 100	*400 000	400 000
Tajikistan	*20 000	*30 000	*30 000	*30 000	*30 000
World Total	2 200 000	2 100 000	1 900 000	1 700 000	1 400 000

Note(s):-

(1) Several countries are believed to have unrecorded production of mercury from copper electrowinning processes and by recovery from effluents

(a) From copper solvent extraction and electrowinning processes

Production of mica

tonnes

Country	2002	2003	2004	2005	2006
Finland	7 170	9 337	9 250	9 500	8 097
France (e)	17 000	18 000	19 000	*20 000	*20 000
Russia	9 159	10 063	8 474	*8 000	*8 000
Serbia	—	—	—	—	*140
Serbia and Montenegro	426	185	140	*140	—
Spain (e)	11 783	11 800	7 825	4 043	...
Madagascar	102	*70	*70	*70	*70
South Africa	821	980	285	924	828
Canada	*17 500	*17 500	*17 500	*17 500	*17 500
Mexico	456	506	424	120	150
USA (d) (e)	81 100	78 600	99 000	78 000	*93 000
Argentina	1 770	1 894	2 518	4 101	6 223
Brazil	*4 000	*4 000	*4 000	*4 000	*4 000
China (c)	*54 000	*66 200	*92 000	*89 000	*94 000
India (b)	3 575	4 002	3 773	4 643	1 415
Iran (f)	2 406	5 500	7 032	6 810	*7 000
Korea, Republic of (a)	29 870	33 645	59 238	36 623	30 356
Malaysia (g)	3 669	3 609	3 544	4 544	5 152
Sri Lanka	1 161	1 674	1 365	1 800	2 600
Taiwan	6 595	3 237	2 979	8 608	4 841
Australia	605	636	383	737	—
World Total	250 000	270 000	340 000	300 000	310 000

Note(s):-

(1) In addition to the countries listed, Romania is believed to produce mica

- (a) Mainly sericite
- (b) Years ended 31 March following that stated
- (c) Conservative BGS estimates, based on exports
- (d) Sold or used by producers
- (e) Including mica recovered from mica schists and/or kaolin beneficiation
- (f) Years ended 20 March following that stated
- (g) Sericite

Mine production of molybdenum

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Armenia	2 883	2 763	2 950	3 030	4 090
Russia	4 800	4 800	4 800	4 800	4 800
Canada	8 043	9 092	9 519	7 935	7 842
Mexico	3 428	3 524	3 731	4 245	2 519
USA	32 300	33 500	41 500	58 000	*60 500
Chile	29 467	33 375	41 883	47 885	43 158
Peru	8 613	9 561	14 246	17 325	17 209
China	30 330	32 220	38 430	*40 000	*41 000
Iran (a)	2 370	2 290	1 890	2 476	*2 500
Kazakhstan	46	53	...	...	...
Kyrgyzstan	*250	*250	*250	*250	*250
Mongolia	1 590	1 803	1 103	1 188	1 404
Uzbekistan	*500	*500	*500	*500	*500
World Total	125 000	134 000	161 000	188 000	186 000

Note(s):-

(1) In addition to the countries listed, Australia, Georgia, India, Democratic P.R. of Korea, Romania and Tajikistan are believed to produce molybdenum

(a) Years ended 20 March following that stated

Production of nepheline syenite

tonnes

Country	2002	2003	2004	2005	2006
Norway	330 461	332 000	329 000	320 000	330 000
Russia (a)	1 021 576	1 014 279	1 023 257	*1 000 000	*1 000 000
Canada	715 000	705 000	699 000	745 000	719 000

Note(s):-

(a) Nepheline concentrates

NICKEL

Characteristics

Nickel is hard and corrosion resistant and has a relatively high melting point of 1453°C, nearly as high as that of iron. It is, nevertheless, malleable and ductile allowing it to be readily worked into sheets or wire. It has excellent strength and toughness at extremes of temperature. It has low thermal and electrical conductivities, and is capable of being magnetized although not as strongly as iron. It is attractive and very durable as a pure metal, and alloys readily with many other metals.

Nickel is rarely found in the earth in its pure form, but occurs principally as oxides, sulphides and silicates. The majority of economic nickel deposits occur in two geological environments. These are magmatic sulphide deposits and lateritic deposits. Sulphide deposits may be formed during slow crystallisation of a magma body at depth or in ancient lava flows. The principal ore mineral is pentlandite [(Ni,Fe)₉S₈]. Nickel-bearing lateritic ores are formed by tropical and sub-tropical surface weathering. The principal ore minerals are nickeliferous limonite [(Fe,Ni)O(OH)] and garnierite (a hydrous nickel silicate). Mining exploits both sulphide and laterite ores in almost equal proportions although laterites currently account for around 70 per cent of known nickel deposits. The rapid development of nickeliferous pig-iron production in China has made the economic exploitation of lower grade oxide ores possible.

Nickel ores are widespread, but the principal nickel mining countries are Russia, Canada, Australia, Indonesia, New Caledonia, Colombia and Brazil. Important nickel refineries treating imported raw materials operate in Norway, Finland, France, Japan and the United Kingdom

Nickel is normally extracted from sulphide ores using pyrometallurgical processes (smelting) followed by electrolytic refining. A vapometallurgical refining process is also used. Lateritic ores may be smelted directly to ferronickel or treated by hydrometallurgical leaching processes, using either ammonia or acids. The newest technology is bio-oxidation leach processes, with heap leaching attracting increasing interest.

Primary nickel is marketed as nickel metal with varying purities, and as nickel oxides. Ferronickel, with a nickel content of 25 to 40 per cent, is an intermediate product that is added to alloy steel melts particularly in the production of stainless steel.

Nickel in the form of scrapped alloy steel or nickel-based alloy is also readily recycled, and large tonnages of this secondary nickel are used to supplement newly mined metal.

Uses

Nickel is used as pure metal only in electroplating applications for corrosion resistance e.g. medical equipment, scissors and cosmetic applications such as domestic fittings and vehicle parts, giving them a hard, tarnish-resistant shiny surface. More than 80 per cent of nickel production is combined with other metals, especially iron, chromium and copper, to form alloys. Nickel adds toughness, strength, rust resistance and other electrical, magnetic and heat resistant properties. Stainless steels containing, typically, eight to 12 per cent nickel, account for about two-thirds of nickel consumption (International Nickel Study Group, 2008) and are used in construction, the chemical and food-processing industries and household products Nickel-based high-performance alloys are critical in

the aerospace industry. Nickel is also used in the manufacture of rechargeable (nickel-cadmium) batteries, in computer hard discs, in coinage, jewellery and in electrical components.

World production in 2006

Nickel mine production reached a record total of 1526 thousand tonnes in 2006, the largest producers being, in order, Russia, Canada, Australia, Indonesia and New Caledonia. World refined nickel production also reached a record high of 1337 thousand tonnes in 2006, an increase of four per cent on 2005 and 12 per cent over the last five years. The largest producers were Russia, which produced 272 000 tonnes, Canada 153 743 tonnes, Japan 149 954 tonnes, and Australia 116 000 tonnes. Japanese output was entirely based on imported raw materials

Countries with mainly lateritic nickel resources, such as Colombia, Indonesia and Brazil, are increasing production and beginning to take over from the diminishing, but still substantial, magmatic sulphide resources in Russia, Canada and Australia.

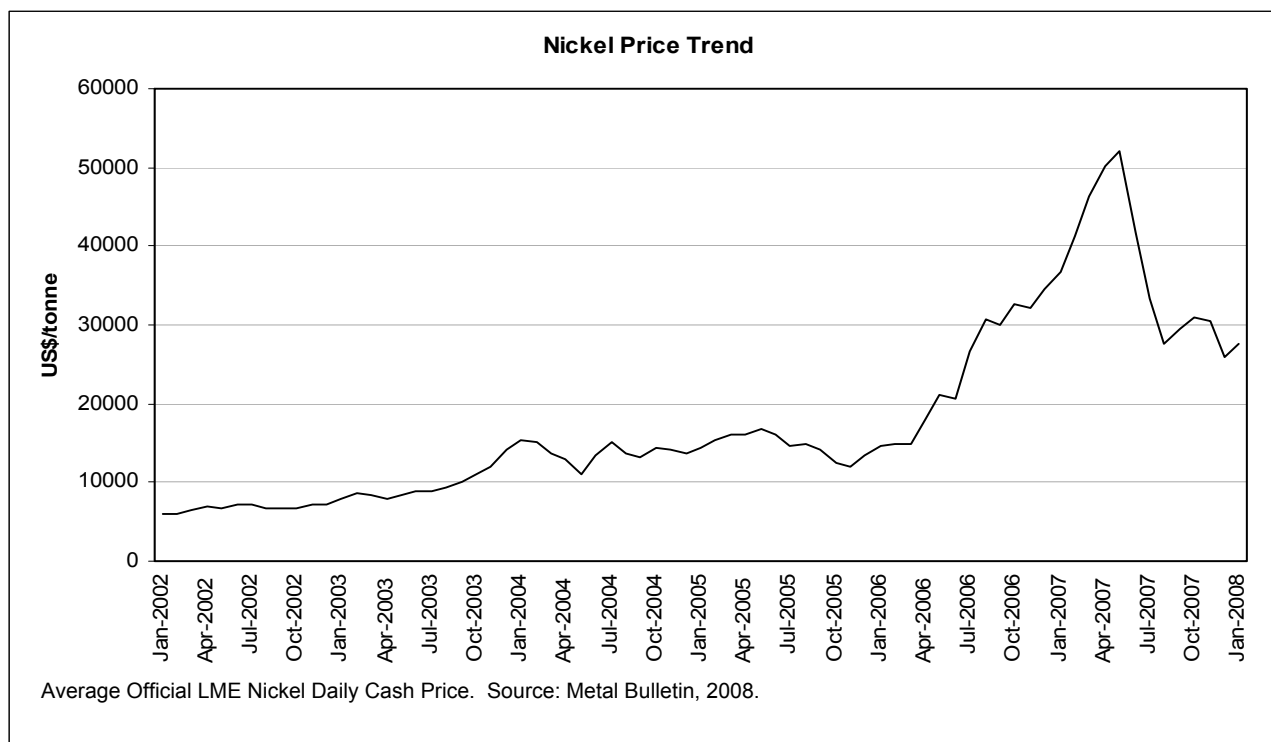
The rise in nickel production has been driven by an increase in consumption in Western Europe and in China in particular, to supply its growing steel industry.

Prices

The price of nickel has experienced periods of volatility over the last twenty years. The price decrease in the first half of the 1990s has been attributed to the economic collapse of the former 'Eastern Bloc' countries which caused a surge of nickel exports, driving down nickel prices below the cash costs of production and resulted in reduced nickel production in the 'West' (International Nickel Study Group, 2008). Until 2003 the nickel cash price remained below US\$10 000 per tonne (see figure). The price began to escalate dramatically from November 2005, continuing throughout 2006 and into 2007, reaching an all time high in May 2007 before decreasing by the end of the year (see graph).

The beginning of 2007 saw increasing nickel prices in response to low stocks, and increasing demand from China for stainless steel production. In January the news that BHP Billiton had been forced to temporarily close some of its Western Australian operations fed the price rises (Garvey, 2007a), and strikes at Xstrata's Sudbury nickel works in Canada, accompanied by dwindling stocks in the LME's warehouses, further fuelled price rises (Garvey, 2007b). Supplies to the market were cut further with the cessation, in early May, of nickel shipments from the Port of Esperance in Western Australia while the port updated its ore-handling equipment and environmental procedures. LionOre Mining Ltd and Jubilee Mines NL were affected by these cuts (Mining Journal, 2007a).

Nickel prices reached a record high of US\$54 200 per tonne on 16 May 2007 (Metal Bulletin prices), before they began to fall as concern grew that the Chinese steel industry was considering production cuts. This decline began prior to a change in LME trading rules, and despite LME nickel stocks reaching records lows, with less than two days consumption in the stockpiles by early June (Haycock 2007a). The LME imposed new nickel lending rules on 6 June, which stipulated that two or more parties holding 25 per cent or more in the market would be subject to lending restrictions. The nickel



price immediately plunged by a further five per cent (Mining Journal, 8 June 2007).

The news that the South Korean giant POSCO had developed a no-nickel stainless steel and that other companies were turning to ferronickel substitute put further downward pressure on nickel prices (Haycock, 2007b). Nickel prices also pushed steel makers to increase production of steels with higher chromium or manganese content, and the amount of standard grade stainless (8% Ni) fell to around 45 per cent world production from 50–60 percent in previous years (Mining Journal, 2007c). The price decline continued into July as some of the world's biggest nickel producers, including Brazilian giant CVRD (now Vale) and Russian major, Norilsk Nickel, declared record half-year profits (Haycock, 2007c). Prices continued to decline throughout the second half of the year, falling to US\$25 805 per tonne by 31 December, with rising stockpiles playing a significant role, and following the trend seen in other base metals.

By the end of 2007, nickel stocks had risen almost six-fold since the beginning of the year, with falling prices failing to curb supply. Analysts suggest that prices are unlikely to increase given the lagging demand resulting from declining growth in the US housing market, although China's growth may compensate for reduced US demand (Seatter, 2008).

Industry events in 2007

The high prices stimulated increased output in the mining sector, with the major mining companies investing significantly in nickel metal during 2006, continuing through 2007. Exploration has been progressing with significant discoveries, and new projects have come on line.

Takeover activity has resulted in significant consolidation within the industry and the biggest news has been the struggle for supremacy in the market. Seven companies now account for 60 per cent of world primary production (Mining Journal 2007d). Last year CVRD (now rebranded as Vale) bought Inco, Xstrata purchased Falconbridge and Norilsk incorporated OMG's nickel interests.

Norilsk Nickel strengthened its leading position both in the Russian and the international mining and metals industry during 2007. On 1 March Norilsk Nickel acquired the Harjavalta refinery in Finland and the Cawse operation in Australia from the OM Group. On 1 July Norilsk Nickel went on to acquire Tati Nickel in Botswana, Nkomati in South Africa as well as the Waterloo, Lake Johnston and Black Swan operations in Australia as part of the acquisition of LionOre Mining International Ltd (Norilsk, 2008).

Australia remains one of the most significant producers and Queensland will have its first new nickel mine in more than 16 years when Metallica Minerals starts production at its Lucky Break joint venture project next year (MiningNews.net, 2007).

China continues to have a major influence on the nickel market despite its increasing reliance on low-grade laterite ore for nickel pig-iron production (see below). Chinese mining companies continue to invest overseas. In Zambia, Albidon recently signed an Offtake Agreement with China's largest nickel producer the Jinchuan Group for the purchase of nickel concentrates from its Munali project, over the life of the project (Chadwick and Higgins, 2007). Jinchuan also bought an 11 per cent stake in Fox Resources Ltd, and signed further life-of-mine offtake agreements covering all nickel and copper concentrates produced from Fox's Sholl B2 nickel project and its Radio Hill operation in the Pilbara region of Western Australia (Fox Resources Ltd, 2007). Nevertheless, Chinese nickel exports are set to drop after the Chinese Government increased export tax on 1 November 2007 from 1 to 15 per cent (Metal Bulletin, 2007a).

One of the most significant industry developments over the past two years (since 2005) has been the emergence of low-grade ferronickel, or nickeliferous pig-iron. In response to the high nickel price of refined nickel, Chinese steel makers have been importing low grade laterite ore, mainly from the Philippines (limonitic clay c. 1.1% Ni), but also from Indonesia, and converting it in steel furnaces to a low-grade ferronickel product (2–3% Ni) that can be used by at least some domestic stainless steel producers (Garvey, 2007c). In April 2007, Baosteel, China's biggest steel maker confirmed that it was using nickel pig-iron as a raw material (Metal Bulletin, 2007b). It also confirmed that it has been testing the

low-grade alternative in trial production runs of its 300-series stainless steel although at present pig-iron has been used predominantly in the consumer goods sector (200-series stainless) rather than higher quality industrial sector. Some Chinese companies have even bought purpose-built blast furnaces for nickeliferous pig-iron production, suggesting it is more than a short-term stop-gap (Foster and Ho, 2007). Nevertheless, in the long-term, the Chinese authorities may impose new regulations on the use of nickeliferous pig-iron, as its production is not only energy intensive but produces high levels of pollution. Some pig-iron producers also add fluorspar to their blast furnaces to increase the fluidity of the slag, which has serious consequences for the local environment (Metal Bulletin, 2007a). In the meantime, increased demand for laterite ore has resulted in inflated prices.

Kosovo also rejoined the global nickel market with the privatization of the Ferronikeli mining complex in Drenas. Production resumed after eight years under new owner, International Mineral Resources (IMR). IMR have invested over US\$60 million since April 2006 to repair war damage. Ferronikeli has three open-pit lateritic nickel mines and intend to produce ferronickel for export. The plant was set up in 1984 using Soviet technology, but now includes Western units (Mining Journal, 2007f).

Perth-based Rusina Mining added to its landholding in the Philippines near its Acoje nickel mine (Rusina Mining, 2007).

Confidence in nickel remains, illustrated by the approval of a massive US\$3.8 billion investment by Xstrata plc in its Koniombo lateritic nickel project in New Caledonia. This is billed by the company as the most attractive undeveloped nickel resource in the world (Mercer, 2007).

Despite the price slump during December, Stonehenge Metals (Perth, Australia) went ahead with a deal to acquire an 85 per cent stake in the Mandiodo laterite nickel project in Sulawesi, Indonesia, from PT Global Titik Persada (Stonehenge Metals, 2008). Rio Tinto, one of the world's largest mining companies signalled its faith in continuing strong demand for nickel by its commitment to go ahead with the \$US300 million Eagle Mine in Michigan and was negotiating for another nickel mine in Sulawesi, Indonesia (Rio Tinto, 2007).

New bioleaching technology has attracted increasing interest for nickel extraction and also its potential for use on low-grade ores and reworking waste dumps. The heap leaching of laterites especially has gathered momentum in recent times since AIM-listed European Nickel brought its Caldag laterite leach operation online in Turkey (Garvey, 2007d). GME Resources Ltd identified the bio-heap leaching as its preferred processing method for its NiWest lateritic nickel-cobalt project in Western Australia (Mining Journal, 2007b). The flat terrain and arid conditions of the Western Australian goldfields are especially favourable to heap leaching. Finland's Talvivaara Mining Co Ltd is set to become the first company to apply bio-heap leaching to the commercial scale extraction of nickel from sulphide ore at the company's two polymetallic deposits (Kuusilampi and Kolmisoppi) in Sotkampo. Overburden removal began in November 2007 and is on schedule to begin mining late next year (Talvivaara Mining Co. Ltd, 2008).

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Mine production of nickel

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Finland	3 500	3 400	3 400	3 400	2 800
Greece	22 700	19 100	19 000	20 400	21 700
Norway	2 052	—	382	342	362
Russia	267 300	291 000	290 000	*300 000	*300 000
Spain	—	—	—	5 380	6 400
Turkey	—	640	—	700	2 600
Botswana	23 896	27 400	22 292	28 212	26 762
South Africa (a)	38 546	40 842	39 851	42 497	41 599
Zimbabwe	7 835	6 678	9 776	7 799	8 825
Canada	189 297	163 244	186 694	198 932	233 461
Cuba	71 300	74 000	71 900	*73 800	74 000
Dominican Republic	37 521	45 253	46 000	*46 000	*46 500
Brazil	44 928	45 456	44 928	74 198	82 492
Colombia	58 500	70 800	75 100	89 000	94 100
Venezuela	17 000	18 800	19 000	18 500	18 200
China	53 700	61 100	75 600	72 700	68 900
Indonesia	121 600	143 900	142 700	150 000	150 000
Philippines	24 234	19 537	16 973	22 560	58 900
Australia	207 800	191 000	187 000	189 000	185 000
New Caledonia	99 841	112 013	119 199	111 939	102 986
World Total	1 292 000	1 334 000	1 370 000	1 455 000	1 526 000

Note(s):-

(a) Includes metal and metal content of sulphate and concentrates

Smelter/refinery production of nickel

tonnes

Country	2002	2003	2004	2005	2006
Austria	*1 000	*1 000	300	400	1 000
Finland	55 348	50 989	49 580	39 159	47 469
France	11 444	11 370	12 103	12 684	13 700
Greece	19 230	18 000	18 116	19 235	17 700
Norway	68 500	77 183	71 410	85 374	82 257
Russia	243 000	260 000	260 400	266 600	272 400
Ukraine	*3 000	*4 000	4 800	13 000	15 900
United Kingdom	33 800	24 200	38 600	37 100	36 800
South Africa	38 500	40 800	39 851	42 392	41 600
Zimbabwe	18 900	16 300	16 200	15 900	13 200
Canada	144 476	124 418	151 518	139 683	153 743
Cuba	39 500	42 300	38 800	39 100	*39 100
Dominican Republic	23 303	27 227	29 477	28 668	29 675
Brazil	29 961	30 514	32 101	36 315	36 569
Colombia	43 412	46 482	48 016	52 749	51 137
Venezuela	17 000	18 800	19 000	18 500	18 200
China	52 400	64 700	75 800	97 400	137 700
Indonesia	8 804	8 933	7 945	7 300	14 474
Japan	157 900	165 100	169 500	163 243	149 954
Australia	132 200	129 000	122 000	121 000	116 000
New Caledonia	48 650	50 666	43 016	46 738	48 723
World Total	1 190 000	1 212 000	1 249 000	1 283 000	1 337 000

Note(s):-

(1) Data relate to refined nickel plus the nickel content of ferro-nickel, nickel oxide and nickel salts

Production of perlite

tonnes

Country	2002	2003	2004	2005	2006
Armenia	96 264	106 623	29 996	49 963	...
Bulgaria	10 500	16 800	8 500	15 300	4 500
Georgia	*5 000	*5 000	*5 000	*5 000	*5 000
Greece	838 997	1 079 036	1 053 388	*1 100 000	*1 100 000
Hungary	72 196	95 100	65 000	69 900	71 019
Italy	*60 000	*60 000	*60 000	*60 000	*60 000
Russia	*45 000	*45 000	*45 000	*45 000	*45 000
Slovakia	18 635	15 000	23 840	8 630	10 560
Turkey	151 902	136 683	133 829	156 935	*160 000
Ukraine	*26 000	*24 000	*26 000	38 200	36 400
South Africa	*1 200	*1 200	*1 200	*1 200	*1 200
Mexico	85 703	194 463	188 027	91 724	81 719
USA	521 000	493 000	508 000	508 000	*457 000
Argentina	17 152	21 480	21 193	21 991	25 146
China	*600 000	*650 000	*700 000	*700 000	*1 380 000
India (a)	283	279	355	122	68
Iran (b)	20 000	26 495	31 259	30 051	*30 000
Japan	*250 000	*240 000	*240 000	*240 000	*240 000
Philippines	8 500	15 200	12 100	9 700	*8 800
Thailand	7 600	5 700	26 400	14 500	22 000
Australia (c)	8 300	9 440	9 952	10 634	12 057
New Zealand	*3 000	*5 000	5 600	7 310	3 552

Note(s):-

(1) In addition to the countries listed, Algeria, Canada, Iceland, Mozambique and former Yugoslavia are believed to produce perlite

(a) Years ended 31 March following that stated

(b) Years ended 20 March following that stated

(c) Years ended 30 June of that stated

Production of crude petroleum

tonnes

Country	2002	2003	2004	2005	2006
Albania	355 817	359 253	399 740	448 041	...
Austria	1 032 204	1 014 716	981 588	933 040	944 637
Azerbaijan	15 333 500	15 251 300	15 348 800	22 214 200	32 185 900
Belarus	1 846 000	1 820 400	1 804 040	1 785 020	1 800 000
Bulgaria	33 000	27 900	33 100	30 000	27 500
Croatia	1 108 434	1 052 121	1 037 787	980 486	950 859
Czech Republic	253 000	310 000	299 000	306 000	259 000
Denmark	18 494 000	18 341 000	19 446 000	18 822 000	17 068 000
Estonia (d)	*1 438 000	*1 463 000	*1 314 000	*1 692 000	*1 635 000
France	1 316 890	1 219 000	1 288 000	1 179 000	1 100 000
Georgia	73 900	139 700	97 600	66 600	63 506
Germany	3 768 054	3 799 864	3 515 537	3 572 764	3 514 284
Greece	207 000	162 000	132 890	100 678	...
Hungary	1 049 770	1 134 245	1 076 844	947 542	880 000
Italy	5 531 000	5 570 000	5 445 000	6 100 000	5 800 000
Lithuania	433 700	382 400	301 874	216 634	180 894
Netherlands	3 073 924	3 076 398	2 890 979	2 268 746	2 022 475
Norway	157 847 000	153 508 000	150 974 000	139 800 000	128 700 000
Poland	727 973	764 806	886 188	847 844	795 742
Romania	5 810 000	5 651 000	5 462 000	5 212 000	5 000 000
Russia	380 000 000	421 000 000	459 000 000	470 000 000	480 000 000
Serbia	—	—	—	—	*650 000
Serbia and Montenegro	681 544	670 745	652 270	648 000	—
Slovakia	51 921	47 953	42 410	33 150	30 520
Spain	326 197	329 171	262 707	166 014	142 922
Turkey	2 440 202	2 375 082	2 275 529	2 280 764	2 175 353
Ukraine	3 700 000	3 966 900	4 314 200	4 413 800	4 561 000
United Kingdom	108 023 000	99 055 000	88 831 000	78 809 000	71 426 000
Algeria	61 487 000	76 841 000	81 760 000	*84 900 000	*74 380 000
Angola	44 600 000	43 600 000	49 000 000	61 000 000	69 400 000
Cameroon	3 700 000	3 500 000	3 200 000	2 900 000	3 190 000
Chad	—	1 300 000	8 800 000	9 300 000	8 000 000
Congo	11 937 000	11 163 000	11 209 000	*11 830 000	*12 480 000
Congo, Democratic Republic	12 550 000	11 670 000	*11 100 000	*11 000 000	*11 000 000
Egypt	34 925 000	*35 000 000	*33 250 000	*31 950 000	*31 150 000
Equatorial Guinea	11 700 000	12 300 000	17 400 000	17 800 000	17 700 000
Gabon	14 700 000	12 000 000	13 500 000	13 300 000	11 590 000
Ghana	350 000	410 000	370 000	*370 000	*370 000
Ivory Coast	754 289	928 895	1 020 452	*1 000 000	*1 000 000
Libya	*61 550 000	69 000 000	75 800 000	82 060 000	85 600 000
Mauritania	—	—	—	—	1 432 819
Morocco	12 800	*12 500	*12 500	14 400	*14 400
Nigeria	88 874 000	106 859 000	123 600 000	127 260 000	119 200 000
Senegal	98 100	39 200	27 300	50 600	52 400
South Africa	1 025 000	*780 000	1 042 000	1 113 500	721 000
Sudan	11 500 000	12 600 000	14 900 000	18 560 000	19 600 000
Tunisia	3 535 000	3 224 000	3 400 000	3 459 000	3 261 300
Barbados	53 612	50 899	51 696	47 861	47 133
Canada	120 100 000	121 700 000	122 500 000	127 400 000	131 600 000
Cuba	3 533 400	3 664 000	3 184 706	2 878 386	2 900 000
Guatemala	1 248 953	1 252 104	1 024 000	933 000	816 000
Mexico	185 340 000	195 890 000	197 750 000	194 390 000	190 410 000
Trinidad & Tobago	6 731 294	6 914 300	6 332 472	7 444 890	7 355 280
USA	352 600 000	343 700 000	333 800 000	318 580 043	317 127 357
Argentina	40 242 083	39 307 638	35 910 829	34 117 773	33 806 223
Bolivia	1 438 604	1 551 000	1 891 000	1 957 000	1 888 000
Brazil	77 600 000	80 300 000	79 820 000	88 600 000	93 600 000
Chile	300 000	187 000	183 000	171 000	183 000
Colombia	29 806 000	27 907 653	27 200 000	27 100 000	27 200 000
Ecuador	20 053 000	21 414 000	26 826 000	27 085 000	27 291 000
Peru	4 773 299	4 501 500	4 637 000	5 484 000	5 578 000
Suriname	733 000	690 000	661 000	707 000	774 000
Venezuela	158 609 000	131 400 000	150 000 000	151 000 000	145 100 000

Production of crude petroleum

tonnes

Country	2002	2003	2004	2005	2006
Bahrain	1 870 000	1 870 000	1 867 000	1 822 000	1 790 000
Brunei	10 096 000	10 306 000	10 300 000	10 100 000	10 800 000
Burma	858 000	1 051 000	1 044 000	1 100 000	*1 000 000
China (a)	166 900 000	169 600 000	174 502 900	180 838 900	183 675 900
East Timor	—	—	168 000	136 000	119 000
India (e)	33 044 000	33 373 000	34 015 000	32 204 000	33 982 000
Indonesia	63 277 000	57 839 000	54 495 000	54 800 000	51 900 000
Iran	172 700 000	203 700 000	207 900 000	207 300 000	209 800 000
Iraq	104 000 000	66 100 000	100 000 000	90 000 000	98 100 000
Israel	4 560	3 736	3 155	3 114	3 500
Japan	653 000	757 000	783 000	834 000	818 000
Jordan	1 500	1 400	1 200	1 200	1 400
Kazakhstan	47 270 700	45 376 300	59 484 800	61 486 000	65 000 000
Kuwait (c)	98 200 000	114 800 000	122 600 000	130 100 000	133 200 000
Kyrgyzstan	75 500	69 500	73 800	100 000	100 000
Malaysia	33 300 000	35 200 000	36 400 000	33 600 000	33 400 000
Mongolia	19 000	25 000	29 700	28 000	50 000
Oman	44 700 000	40 800 000	38 900 000	38 600 000	36 730 000
Pakistan (b)	3 093 000	3 128 000	3 017 000	3 216 000	3 191 000
Philippines	277 000	690 000	624 000	721 000	...
Qatar	35 100 000	41 200 000	44 900 000	46 900 000	50 600 000
Saudi Arabia (c)	425 300 000	485 100 000	506 000 000	526 800 000	514 600 000
Syria	27 100 000	28 000 000	26 400 000	22 531 000	19 427 500
Taiwan	51 106	45 760	44 563	32 389	23 564
Tajikistan	20 000	17 700	18 900	21 300	20 000
Thailand	6 900 000	8 600 000	8 300 000	9 900 000	11 400 000
Turkmenistan	9 000 000	10 000 000	9 600 000	9 500 000	8 100 000
United Arab Emirates	108 500 000	122 200 000	124 700 000	129 000 000	138 300 000
Uzbekistan	7 200 000	7 100 000	6 600 000	5 400 000	5 400 000
Vietnam	16 863 000	17 700 000	20 051 000	18 519 000	17 200 000
Yemen, Republic of	20 958 000	20 609 000	19 300 000	19 100 000	18 300 000
Australia	33 000 000	27 000 000	20 748 000	21 439 000	20 831 000
New Zealand	1 363 600	1 052 400	913 600	855 000	819 000
Papua New Guinea	2 120 985	2 282 000	2 680 000	2 200 000	2 263 000
World Total	3 555 000 000	3 680 000 000	3 846 000 000	3 889 000 000	3 889 000 000

Note(s):-

(1) The figures shown in this table include natural gas liquids

- (a) Including oil from shale and coal
- (b) Years ended 30 June of that stated
- (c) Including shares of production from the Neutral Zone
- (d) From oil shale
- (e) Years ended 31 March following that stated

Production of natural gas

million m³

Country	2002	2003	2004	2005	2006
Albania	10	12	12	11	...
Austria	2 015	2 029	2 011	1 654	1 765
Azerbaijan	5 144	5 128	4 995	5 732	6 322
Belarus	246	254	245	228	200
Bulgaria	11	11	333	573	519
Croatia	2 122	2 190	2 198	2 384	2 714
Czech Republic	91	131	175	356	148
Denmark	7 947	7 552	8 946	9 908	9 873
France	1 751	1 523	1 325	1 089	1 167
Georgia	17	18	11	15	21
Germany	21 556	22 228	20 411	19 171	19 776
Greece	36	27	23	16	...
Hungary	3 130	3 145	3 112	3 041	3 250
Irish Republic (b)	839	673	848	570	507
Italy	14 623	13 885	12 961	11 977	11 000
Netherlands	71 786	69 114	81 499	74 460	73 300
Norway	65 501	72 905	78 351	84 702	87 490
Poland	5 263	5 315	5 630	5 742	5 651
Romania	13 647	13 174	13 246	12 120	12 720
Russia	561 000	581 000	632 000	641 000	656 000
Serbia	—	—	—	—	...
Serbia and Montenegro	400	364	318	282	—
Slovakia	212	201	178	151	137
Slovenia	5 704	4 926	5 500	5 500	4 200
Spain	553	268	370	174	118
Turkey	242	276	344	484	307
Ukraine	18 700	19 333	20 192	20 787	21 067
United Kingdom	110 154	108 441	101 572	93 392	84 170
Algeria	95 057	92 434	91 439	88 200	84 500
Angola	600	650	750	910	1 020
Egypt	19 605	17 680	14 090	33 727	44 800
Equatorial Guinea	1 050	1 220	1 390	2 300	2 000
Gabon	100	125	102	*100	*100
Ivory Coast	1 610	1 457	2 000	2 200	*2 200
Libya	6 210	6 400	7 000	11 300	14 800
Morocco	49	*49	*49	*49	*49
Nigeria	15 120	19 200	22 388	22 400	28 200
South Africa	*1 000	...	...	...	...
Tunisia	2 679	2 687	2 827	2 873	2 394
Canada	179 037	173 700	175 364	176 510	176 776
Cuba	585	658	704	743	1 085
Mexico	35 310	36 400	37 400	39 200	43 400
Trinidad & Tobago	17 127	25 774	29 628	33 270	40 082
USA (e)	537 000	541 000	526 000	512 000	525 000
Argentina	40 311	50 633	52 385	51 573	51 778
Bolivia	6 421	7 398	10 257	12 536	14 434
Brazil	10 000	10 900	11 900	12 200	12 700
Chile	2 543	2 181	2 106	2 394	2 106
Colombia	6 200	6 100	6 400	6 800	7 300
Ecuador	113	142	170	255	283
Peru	687	759	849	1 586	1 784
Venezuela	28 415	25 200	28 100	28 900	28 700
Afghanistan	*3 000	*3 000	*3 000	*3 000	...
Bahrain	9 405	11 799	11 595	12 692	13 436
Bangladesh (d)	11 087	11 926	12 827	13 605	14 921
Brunei	11 200	12 400	11 800	11 500	12 300
Burma	8 400	9 600	10 200	13 000	13 400
China	32 700	35 015	41 493	49 953	58 553
East Timor	—	—	6 157	9 337	11 268
India (c)	29 964	30 908	30 820	31 223	30 648
Indonesia	68 795	69 341	66 998	*67 000	*68 000
Iran	75 000	79 000	91 800	100 900	105 000
Iraq	2 360	1 100	1 750	2 650	3 500

Production of natural gas

million m³

Country	2002	2003	2004	2005	2006
Israel	9	8	1 192	1 656	2 313
Japan	2 495	2 836	2 794	3 263	3 302
Jordan	256	288	294	242	251
Kazakhstan	6 018	7 557	11 598	14 023	25 700
Kuwait (a)	8 000	8 900	11 000	12 300	12 900
Kyrgyzstan	30	27	29	30	20
Malaysia	48 308	50 810	53 670	59 880	59 640
Oman	16 000	17 800	18 000	19 600	25 657
Pakistan (d)	26 158	28 107	34 058	38 085	39 644
Qatar	29 500	28 000	33 300	45 800	49 500
Saudi Arabia (a)	57 320	60 060	65 680	71 240	73 461
Syria	6 821	9 260	8 200	6 300	8 272
Taiwan	887	831	796	548	463
Tajikistan	30	32	34	27	18
Thailand	20 450	21 299	22 317	23 676	24 492
Turkmenistan	53 500	59 100	*58 600	*63 200	62 200
United Arab Emirates	43 390	44 800	46 290	47 000	47 400
Uzbekistan	*57 400	*57 300	*59 600	59 600	55 400
Vietnam	2 135	2 712	6 269	6 440	7 000
Australia	32 606	33 180	35 257	37 129	38 883
New Zealand	5 942	4 895	4 502	4 222	4 320
Papua New Guinea	105	139	156	154	153
World Total	2 589 000	2 659 000	2 782 000	2 867 000	2 960 000

Note(s):-

(1) So far as possible the figures in this table exclude flared or reinjected gas

(a) Including one-half of the output of the Neutral Zone

(b) Sales

(c) Years ended 31 March following that stated

(d) Years ended 30 June of that stated

(e) Dry gas

Production of phosphate rock

tonnes

Country	2002	2003	2004	2005	2006
Finland	799 814	799 339	838 000	823 000	857 922
Russia	10 763 000	11 072 600	11 345 300	11 317 400	10 866 800
Algeria	741 000	905 000	784 000	902 300	1 510 233
Burkina Faso	2 350	2 400	2 400	*2 400	*2 400
Egypt	1 218 561	2 183 200	2 218 900	3 269 538	2 176 900
Morocco	23 028 000	23 338 000	26 675 000	28 788 000	27 097 500
Senegal					
Phosphate rock	1 549 100	1 499 600	1 576 000	1 451 000	584 000
Aluminium phosphate (a)	1 557	3 516	1 600	1 520	1 500
South Africa	2 803 265	2 642 970	2 735 150	2 576 885	2 628 714
Tanzania	*7 650	3 738	6 570	1 975	3 700
Togo	1 280 600	1 471 200	1 115 200	1 020 900	1 156 500
Tunisia	7 461 000	7 889 900	8 050 800	8 220 400	7 838 000
Zimbabwe	84 926	80 034	83 391	45 705	65 838
Canada	1 003 000	980 500	1 064 000	888 000	530 000
Mexico	4 764	5 500	350	350	7 500
USA	36 100 000	35 000 000	35 800 000	36 300 000	*30 700 000
Brazil (d)	5 083 703	5 583 778	5 689 000	5 631 000	5 801 000
Chile	19 541	21 300	21 465	20 363	13 836
Colombia	*43 000	*43 000	*43 000	*43 000	*43 000
Peru	45 252	11 610	45 504	—	—
Venezuela	390 342	260 008	300 057	392 000	*400 000
China	*26 000 000	24 470 000	26 174 300	30 450 000	38 959 500
Christmas Island (b) (c) (e)	517 000	585 737	655 474	757 013	724 278
India (f)	1 212 834	1 435 959	1 722 983	1 372 951	1 464 000
Iran	303 000	224 000	229 575	324 166	*300 000
Iraq	*100 000	—	—	—	—
Israel	4 091 000	3 707 000	3 290 000	3 236 000	2 949 000
Jordan	7 123 887	6 762 279	6 222 775	6 374 725	5 804 991
Kazakhstan	1 197 800	1 260 300	1 706 500	1 534 100	1 059 300
Korea, Dem. P.R. of	*100 000	*100 000	*100 000	*100 000	*100 000
Pakistan (e)	1 362	2 562	4 614	2 687	2 996
Sri Lanka	38 775	41 357	43 520	41 978	44 143
Syria	2 482 916	2 400 757	2 882 420	3 500 000	3 664 000
Thailand	3 680	13 870	2 580	3 020	900
Uzbekistan	426 000	433 400	482 000	468 000	600 000
Vietnam	779 000	821 000	902 000	1 065 600	1 215 000
Australia	2 026 971	2 286 247	2 015 597	1 935 630	2 083 454
Nauru (b) (e)	161 950	112 900	*29 000	*18 000	*84 000
World Total	139 000 000	138 000 000	145 000 000	153 000 000	151 000 000

Note(s):-

(1) In addition to the countries listed, Indonesia is believed to produce phosphate rock

(a) Including lime phosphates

(b) Exports

(c) Including phosphate dust

(d) Including beneficiated and directly shipped material

(e) Years ended 30 June of that stated

(f) Years ended 31 March following that stated

Mine production of platinum group metals

kilograms (metal content)

Country	2002	2003	2004	2005	2006
Russia					
Platinum	(a) 30 500	(a) 32 700	*28 000	29 100	*29 100
Palladium	(a) 60 000	(a) 92 000	118 200	97 400	98 400
Other platinum metals	*14 500	*15 000	*15 500	*15 600	*15 600
South Africa					
Platinum	133 796	148 348	153 239	168 749	168 125
Palladium	64 244	70 946	76 403	84 908	86 265
Other platinum metals	41 545	46 856	46 759	58 218	53 138
Zimbabwe					
Platinum	2 053	2 330	4 438	4 833	4 998
Palladium	1 728	1 770	3 564	3 879	4 022
Other platinum metals	416	441	810	862	874
Canada					
Platinum	9 500	7 200	*9 100	*7 900	*8 000
Palladium	15 100	11 500	*16 000	*13 800	*14 000
Other platinum metals	1 000	800	*1 000	*900	*900
USA					
Platinum	4 385	4 168	4 043	3 919	4 292
Palladium	14 805	13 996	13 654	13 312	14 401
Colombia					
Platinum	661	841	1 209	1 082	1 438
Australia					
Platinum	122	133	196	58	...
Palladium	811	477	846	603	(b) 722
World Total	395 000	450 000	493 000	505 000	504 000

Note(s):-

- (1) Wherever possible, figures relate to quantities of platinum group metals thought to be recovered from ores originating in the country stated
 - (2) Figures for metal production are only given for countries where recovery is thought to be based predominantly on domestic materials or on imported materials which have not been recorded as mine production elsewhere in the table
 - (3) In addition to the countries listed, Bulgaria, China, Ethiopia, Indonesia and Philippines are believed to produce platinum group metals
- (a) Sales from mine production and stocks
(b) Platinum group metals; all forms

Production of potash

tonnes (K₂O content)

Country	2002	2003	2004	2005	2006
Belarus	3 791 000	4 229 000	4 612 000	4 928 000	4 605 300
France					
Potassic salts	128 000	—	—	—	—
Germany					
Potassic salts	3 471 763	3 563 932	3 626 510	3 663 829	3 624 977
Russia	4 431 600	4 653 300	5 599 100	6 265 600	5 274 100
Spain					
Chloride	406 571	505 527	553 210	550 000	437 000
Ukraine	*60 000	*60 000	*50 000	*65 000	*65 000
United Kingdom					
Chloride	540 100	621 400	539 500	439 200	429 600
Canada					
Chloride	8 515 000	9 093 000	10 332 000	10 140 000	8 528 000
USA					
Potassic salts	1 200 000	1 100 000	1 300 000	*1 200 000	*1 200 000
Brazil					
Chloride	337 266	415 549	403 080	404 871	403 080
Chile					
Chloride	575 000	563 000	559 000	547 000	*450 000
China	*430 000	*450 000	*450 000	450 000	*490 000
Israel					
Chloride	1 918 200	1 958 400	2 138 400	2 224 200	2 187 000
Jordan	1 173 614	1 176 690	1 157 360	1 097 487	1 020 000
World Total	27 000 000	28 400 000	31 300 000	32 000 000	28 700 000

Production of rare earth minerals

tonnes

Country	2002	2003	2004	2005	2006
USA					
Bastnaesite (a)	*5 000	—	—	—	—
Brazil					
Monazite	—	—	731	958	958
China (a)	88 000	92 000	98 300	119 000	*120 000
India					
Monazite (b)	2 856	2 891	149	122	*120
Malaysia					
Monazite	441	795	1 683	320	894
Xenotime	—	—	—	—	217

Note(s):-

- (1) With the exception of the data for USA and China, figures in this table refer to gross tonnage of concentrates
(2) In addition to the countries listed, rare earth minerals are believed to be produced in Brazil, Indonesia, Kazakhstan, Democratic P.R. of Korea, Republic of Korea, Kyrgyzstan, Mozambique, Nigeria, Russia, Vietnam

- (a) REO content. Assumed to be 60% of concentrates produced
(b) Years ended 31 March following that stated

Production of salt

tonnes

Country	2002	2003	2004	2005	2006
Albania					
Sea salt	22 746	21 448	24 783	47 219	...
Armenia	30 330	31 854	31 625	34 682	37 000
Austria					
Rock salt	1 491	1 610	1 228	1 497	1 336
Salt in brine	641 634	723 286	745 670	771 455	764 103
Azerbaijan	5 380	7 645	9 234	11 202	12 000
Belarus	1 369 000	1 543 136	1 883 138	1 839 300	*1 800 000
Bosnia & Herzegovina	*400 000	179 299	260 456	392 940	416 305
Bulgaria	1 800 000	1 882 000	1 900 000	1 900 000	2 000 000
Croatia	30 483	32 533	32 723	36 970	29 589
Denmark	*590 000	*600 000	*600 000	*600 000	*600 000
France					
Rock salt	434 000	320 000	406 000	494 000	...
Brine salt	1 456 000	1 409 000	1 433 000	1 468 000	...
Salt in brine	4 056 000	4 351 000	4 408 000	4 750 780	(k) 9 371 000
Sea salt	848 000	1 302 000	1 365 000	1 026 000	...
Germany					
Rock salt	6 134 000	6 178 000	7 268 000	8 258 000	9 280 000
Brine salt	1 249 000	1 123 000	974 000	1 006 000	1 001 000
Salt in brine	6 310 000	6 668 000	7 212 000	7 449 000	7 189 000
Greece	126 118	192 161	187 522	198 024	*200 000
Italy					
Rock salt & brine salt	3 342 992	2 922 251	2 876 469	2 988 051	*3 000 000
Montenegro					
Sea salt	—	—	—	—	5 000
Netherlands	5 773 000	5 980 000	5 896 000	6 155 000	6 056 000
Poland					
Rock salt	838 858	847 880	1 099 072	1 123 219	1 129 875
Brine salt	2 719 131	2 790 996	2 940 169	2 889 941	2 899 076
Portugal					
Rock salt	604 969	602 035	661 704	597 945	586 190
Sea salt	40 139	86 603	75 400	92 495	76 610
Romania	2 257 886	2 416 970	2 399 956	2 442 640	2 619 435
Russia	*2 800 000	*2 800 000	*2 800 000	*2 800 000	*2 800 000
Serbia					
Rock salt	—	—	—	—	...
Sea salt	—	—	—	—	...
Serbia and Montenegro					
Rock salt	13 334	15 413	10 344	...	—
Sea salt	3 787	36 469	22 239	...	—
Slovakia	97 400	133 100	121 600	105 100	122 500
Slovenia	5 200	3 632	2 852	803	1 624
Spain					
Rock salt	2 559 760	2 562 832	2 656 904	2 894 526	(k) 4 000 000
Sea salt	1 234 679	1 327 108	1 227 625	1 368 960	...
Other salt	97 945	97 730	108 733	125 836	...
Switzerland	400 000	461 000	486 000	539 000	543 000
Turkey					
Rock salt	55 305	10 205	6 100	512	...
Sea salt	411 646	556 652	582 440	529 235	*500 000
Other salt	1 729 686	1 675 915	1 569 178	1 196 486	*1 200 000
Ukraine	*2 300 000	2 906 400	4 393 000	4 811 000	5 996 000
United Kingdom					
Rock salt	*1 500 000	*1 700 000	*2 000 000	*2 000 000	*2 000 000
Brine salt	*1 000 000	*1 000 000	*1 000 000	*1 000 000	*1 000 000
Salt in brine (a)	*3 200 000	*3 200 000	*2 800 000	*2 800 000	*2 800 000
Algeria					
Brine salt & sea salt	238 000	241 000	241 800	302 700	259 596
Angola	*30 000	*30 000	*30 000	*30 000	*30 000
Benin (c)	*15 000	*15 000	*15 000	*15 000	*15 000
Botswana	315 259	229 432	208 319	243 945	151 595
Burkina Faso	*5 000	*5 000	*5 000	*5 000	*5 000
Cape Verde	*2 000	*2 000	*2 000	*2 000	*2 000
Djibouti	162 266	137 000	26 000	*78 000	*138 000

Production of salt

tonnes

Country	2002	2003	2004	2005	2006
Egypt (j)	1 341 000	...	1 532 362	...	*1 500 000
Eritrea	116 268	52 414	30 754	6 300	9 737
Ethiopia (d)	61 000	61 000	21 000	24 202	19 271
Ghana	99 593	*250 000	*265 000	250 000	250 000
Guinea	*15 000	*15 000	*15 000	*15 000	*15 000
Kenya (h)	18 848	21 199	31 139	26 595	35 024
Libya	*40 000	*40 000	*40 000	*40 000	*40 000
Madagascar	17 000	*23 000	*23 000	*23 000	*23 000
Mali	*6 000	*6 000	*6 000	*6 000	*6 000
Mauritania	*6 000	*6 000	*6 000	*6 000	*6 000
Mauritius (c)	7 000	7 200	7 000	7 900	...
Morocco	266 903	236 443	240 000	*240 000	*240 000
Mozambique (c)	*80 000	*80 000	*80 000	*80 000	*80 000
Namibia	455 912	651 431	750 821	573 248	603 501
Niger	*2 000	*2 000	*2 000	*2 000	*2 000
Senegal	171 500	235 000	167 800	134 000	198 600
Sierra Leone	1 821	1 004	—	—	—
Somalia	*1 000	*1 000	*1 000	*1 000	*1 000
South Africa	428 887	437 896	332 673	399 087	464 909
Sudan	83 000	*84 000	*84 000	*84 000	*84 000
Tanzania	71 200	58 978	57 062	51 166	34 798
Tunisia (c)	798 000	899 000	1 117 000	1 132 000	1 041 000
Uganda	*5 000	*5 000	*5 000	*5 000	*5 000
Bahamas	1 074 355	1 245 447	1 284 294	1 470 176	1 151 547
Canada					
Rock salt	10 158 045	11 957 298	12 071 303	11 448 141	11 504 207
Other salt (e)	2 114 417	1 994 490	2 052 333	2 047 653	1 901 453
Costa Rica	*37 000	*37 000	*37 000	*37 000	*37 000
Cuba	*180 000	*180 000	205 613	172 592	179 800
Dominican Republic					
Rock salt	29 560	...	...	...	...
Sea salt	*50 000	*50 000	*50 000	*50 000	*50 000
El Salvador (c)	31 552	31 366	*31 000	*31 000	*31 000
Guatemala (c)	*50 000	*60 000	*60 000	*60 000	*60 000
Honduras	*25 000	*26 000	*26 000	*26 000	*26 000
Mexico	7 801 948	7 546 987	8 565 520	9 507 623	8 371 353
Netherlands Antilles	380 805	*400 000	*500 000	*500 000	*500 000
Nicaragua (c)	29 710	31 320	*31 000	*31 000	*31 000
Panama (c)	15 553	13 182	18 608	*23 000	*23 000
USA					
Rock salt (f)	13 500 000	16 300 000	18 300 000	*17 600 000	*17 900 000
Salt in brine (f)	19 300 000	20 000 000	20 500 000	*20 700 000	*21 200 000
Evaporated salt (f)	7 490 000	7 400 000	7 620 000	*6 800 000	*6 900 000
Argentina	1 080 328	1 667 829	1 371 792	1 845 833	1 917 656
Brazil					
Rock salt	1 274 000	1 420 000	1 442 000	1 559 000	1 624 000
Sea salt	4 835 000	5 144 000	5 205 968	5 519 618	5 122 197
Chile	3 502 613	6 213 473	4 938 928	6 067 583	4 580 471
Colombia					
Rock salt	180 714	207 486	232 460	215 905	248 245
Sea salt	351 324	244 053	302 101	445 562	389 630
Ecuador	*90 000	*90 000	*90 000	*90 000	*90 000
Peru	281 098	187 416	248 898	*250 000	*250 000
Venezuela (c)	*350 000	*350 000	*350 000	*350 000	*350 000
Afghanistan	*13 000	*13 000	*13 000	*12 000	*12 000
Bangladesh (j)	...	585 000	620 000	650 000	*650 000
Burma (b) (c)	*35 000	*35 000	*35 000	*35 000	*35 000
Cambodia	72 500	36 000	86 600	90 963	59 000
China	36 024 000	34 377 000	37 100 700	44 547 300	54 031 600
India					
Rock salt	1 900	1 000	3 800	1 800	1 600
Sea salt	14 366 400	11 787 300	11 949 500	15 484 600	13 156 300
Other salt	3 510 900	3 094 100	2 807 900	4 437 500	4 927 900

Production of salt

tonnes

Country	2002	2003	2004	2005	2006
Indonesia	*680 000	*680 000	*680 000	*680 000	*680 000
Iran (g)	1 509 367	1 553 526	1 791 000	2 009 195	*2 000 000
Iraq	203 000	50 000	*50 000	*50 000	*50 000
Israel (c)	570 000	540 000	570 000	570 000	*640 000
Japan (i)	1 282 000	1 263 000	1 225 000	1 227 000	1 166 000
Jordan	15 260	11 976	21 727	29 500	28 800
Kazakhstan	173 564	282 389	347 850	178 167	...
Korea, Dem. P.R. of	*500 000	*500 000	*500 000	*500 000	*500 000
Korea, Republic of	204 512	154 641	340 828	378 887	285 568
Kuwait	42 500	44 700	*45 000	*50 000	50 000
Laos	5 410	16 130	*15 000	34 139	*35 000
Lebanon	15 000	15 000	15 000	*15 000	*15 000
Mongolia	*100 000	*100 000	*100 000	*100 000	*100 000
Oman	14 410	12 300	12 400	*12 400	*12 400
Pakistan					
Rock salt (j)	1 423 478	1 426 067	1 639 516	1 648 223	1 858 931
Sea salt (j)	16 185	16 652	11 555	14 375	15 249
Philippines (c)	460 983	429 160	427 615	420 950	*420 000
Saudi Arabia					
Rock salt & brine salt	547 000	547 000	*550 000	*550 000	*550 000
Sri Lanka	73 784	81 791	78 135	85 179	95 652
Syria	145 018	128 265	141 445	110 000	133 000
Taiwan	247 895	178 826	159 091	114 389	107 713
Tajikistan	*40 000	59 739	59 495	65 992	52 459
Thailand					
Rock salt	908 968	892 243	1 031 200	1 074 214	1 008 251
Other salt	*100 000	*100 000	*100 000	*100 000	*100 000
Turkmenistan	*215 000	*215 000	*215 000	*215 000	*215 000
Uzbekistan	*60 000	*60 000	*60 000	*60 000	*60 000
Vietnam	974 000	909 000	906 000	920 000	*920 000
Yemen, Republic of	125 000	116 000	*120 000	*120 000	...
Australia (l)	9 961 000	10 560 000	11 221 000	12 379 000	11 424 000
New Zealand	130 985	108 460	94 010	*90 000	83 000
World Total	212 900 000	219 800 000	230 500 000	248 000 000	255 600 000

Note(s):-

- (1) This table does not include production of refined salt
- (2) Salt is known to be produced in many countries for which statistics are not available.

- (a) Used for purposes other than salt-making
- (b) Brine salt
- (c) Sea salt
- (d) Years ended 7 July of that stated
- (e) Including salt in brine
- (f) Sold or used by producers
- (g) Years ended 20 March following that stated
- (h) Lake salt
- (i) Years ended 31 March following that stated
- (j) Years ended 30 June of that stated
- (k) Salt; all forms
- (l) Excluding Victoria and the Northern Territory

Production of selenium metal

tonnes

Country	2002	2003	2004	2005	2006
Belgium	*200	*200	*200	*200	*200
Finland	37	52	65	66	70
Germany	*16	*14	*14	*12	12
Poland	68	78	83	82	87
Russia	60	81	85	85	85
Serbia and Montenegro	17	7	—	—	—
Sweden	118	107	131	122	*120
Zambia	*11	*10	*10	*10	*10
Canada	175	253	277	107	117
Peru	70	72	76	70	75
China	*65	*65	*65	*65	*65
India (a)	6	2	—	8	—
Japan	752	734	599	625	730
Kazakhstan	*40	*40	*40	*40	*40
Philippines	*55	*45	*48	*68	*65
Uzbekistan	*20	*20	*20	*20	*20

Note(s):-

(1) In addition to the countries listed, Australia, Chile, the Republic of Korea and Zimbabwe are believed to produce selenium metal

(a) Years ended 31 March following that stated

Production of sillimanite minerals

tonnes

Country	2002	2003	2004	2005	2006
France					
Andalusite	59 000	62 000	68 000	*65 000	*65 000
South Africa					
Andalusite	165 087	164 921	234 625	228 375	*230 000
Zimbabwe					
Kyanite	6 138	5 707	491	—	—
USA					
Kyanite (b)	90 000	90 000	90 000	*90 000	*90 000
Brazil					
Kyanite (c)	*200	*200	*200	*200	...
India					
Kyanite (a)	5 327	9 057	8 208	7 341	8 293
Sillimanite (a)	13 290	19 729	30 711	32 278	27 132
Australia					
Sillimanite	233	206	71	38	—

Note(s):-

(1) A number of other countries produce sillimanite minerals but details of output are not reported

(2) In addition to the countries listed above as producing sillimanite minerals, synthetic mullite is known to be produced in Denmark, France, Hungary and the United Kingdom

(a) Years ended 31 March following that stated

(b) Including related minerals

(c) Including beneficiated and directly shipped material

Mine production of silver

kilograms (metal content)

Country	2002	2003	2004	2005	2006
Armenia	5 500	*4 000	*4 000	*4 000	*4 000
Bulgaria	60 000	*60 000	*60 000	*60 000	*50 000
Finland	*12 000	*12 000	*13 000	*13 000	*13 000
France	709	495	682	—	—
Greece	74 800	7 000	—	6 000	25 500
Irish Republic	7 500	8 500	5 200	10 500	12 900
Italy	*1 000	200	100	100	100
Macedonia	36 832	22 195	—	—	*10 000
Poland	1 342 000	1 332 200	1 372 700	1 262 400	1 265 100
Portugal	19 500	21 100	24 400	23 786	20 076
Romania	*18 000	*18 000	*18 000	*18 000	*18 000
Russia (a)	*400 000	*700 000	*1 062 000	*1 100 000	*1 100 000
Serbia	—	—	—	—	*2 400
Serbia and Montenegro (a)	6 838	2 028	2 275	*2 400	—
Spain	12 792	2 173	3 583	5 227	*5 300
Sweden	320 823	340 701	319 563	309 933	292 255
Turkey	124 000	158 000	122 000	219 000	*220 000
Algeria	1 400	500	—	800	500
Congo, Democratic Republic	2 100	35 700	69 700	53 600	67 600
Ethiopia (b)	900	999	1 133	883	902
Ghana	2 129	3 080	3 035	3 571	3 142
Morocco	276 800	200 430	196 000	210 000	186 000
Namibia (a)	43 632	29 367	27 153	34 102	31 307
South Africa	113 108	87 325	73 124	89 023	86 951
Sudan	3 300	2 800	2 900	*2 900	*2 900
Tanzania	6 690	7 986	13 216	12 480	14 906
Tunisia	*3 000	*3 000	*2 000	*4 000	—
Zimbabwe	3 219	2 483	3 216	3 400	*2 000
Canada	1 407 558	1 310 153	1 337 465	1 123 837	983 474
Honduras	52 796	50 884	48 217	53 617	55 036
Mexico	2 746 989	2 568 877	2 569 478	2 894 161	2 894 161
Nicaragua	2 198	2 040	2 950	2 936	2 929
USA	1 354 000	1 239 400	1 246 100	1 225 800	1 139 500
Argentina	125 878	133 907	172 400	263 766	248 227
Bolivia	460 900	466 300	412 550	420 300	472 210
Brazil	10 000	6 496	6 192	6 672	6 541
Chile	1 210 473	1 312 789	1 360 140	1 399 539	1 607 164
Colombia	6 986	9 511	8 542	7 142	8 399
Peru	2 761 486	2 910 922	3 059 829	3 193 146	3 470 725
Burma (a) (c)	*800	*800	*1 100	*2 300	*2 300
China	*2 200 000	2 400 000	2 450 000	2 500 000	*2 600 000
India (c)	59 502	37 870	10 955	27 950	*50 000
Indonesia	293 520	285 206	262 935	328 749	261 398
Iran	*23 000	*23 000	*25 000	*25 000	*25 000
Japan	103 203	99 162	85 999	54 100	11 500
Kazakhstan (a)	855 612	804 874	707 443	812 095	*810 000
Korea, Dem. P.R. of	*50 000	*50 000	*50 000	*50 000	*50 000
Korea, Republic of	6 802	15 417	50 866	41 489	56 256
Laos	—	3 850	2 735	3 405	6 331
Malaysia	—	—	364	402	411
Mongolia	*21 000	20 471	20 427	19 888	20 378
Philippines	8 810	9 533	9 315	19 150	23 500
Saudi Arabia	10 000	11 000	14 494	13 501	9 590
Uzbekistan	*60 000	*60 000	*60 000	*60 000	*60 000

Mine production of silver

kilograms (metal content)

Country	2002	2003	2004	2005	2006
Australia	2 077 000	1 868 000	2 209 000	2 417 000	1 727 000
Fiji	1 901	1 247	1 523	1 418	494
New Zealand	28 725	29 932	*30 100	43 003	27 221
Papua New Guinea	63 349	61 900	55 600	51 125	51 098
World Total	18 901 000	18 856 000	19 671 000	20 511 000	20 116 000

Note(s):-

(1) Countries producing less than 1000 kg per year include Jamaica, Oman and Thailand

- (a) Smelter and/or refinery production
- (b) Years ended 7 July of that stated
- (c) Years ended 31 March following that stated

Production of natural sodium carbonate

tonnes

Country	2002	2003	2004	2005	2006
Botswana	283 197	234 520	263 358	279 085	255 677
Ethiopia (a)	3 843	4 377	6 550	2 771	2 389
Kenya	304 110	352 560	353 835	360 161	374 210
USA	10 500 000	10 600 000	11 000 000	11 000 000	*10 900 000
Pakistan	3 669	—	—	—	—

Note(s):-

(a) Years ended 7 July of that stated

Production of strontium minerals

tonnes

Country	2002	2003	2004	2005	2006
Spain	171 293	152 383	206 001	336 630	272 000
Turkey	*70 000	*70 000	*60 000	*60 000	*60 000
Morocco	3 780	*2 700	*2 700	*2 700	*2 700
Mexico	94 015	130 329	87 610	110 833	128 321
Argentina (a)	2 595	4 300	6 727	7 233	19 822
China	...	...	500 000	700 000	*700 000
Iran	—	2 100	7 500	672	...
Pakistan (b)	416	27	570	1 855	1 290

Note(s):-

(1) In addition to the countries listed, Germany and Poland are believed to produce strontium minerals

- (a) May contain unbeneficiated material
- (b) Years ended 30 June of that stated

Production of sulphur and pyrites

tonnes (sulphur content)

Country	2002	2003	2004	2005	2006
Austria					
Recovered (d)	54 925	50 568	55 322	54 377	50 097
Belarus					
Recovered (d)	28 162	22 292	32 288	48 663	*30 000
Belgium					
Recovered (c) (d)	359 000	383 000	371 000	376 000	391 000
Bulgaria					
Recovered (c)	245 000	260 000	301 000	312 000	340 000
Recovered (d)	30 000	30 000	25 000	30 000	35 000
Croatia					
Recovered (d)	7 069	7 471	9 000	9 000	7 000
Czech Republic					
Recovered (d)	40 000	45 000	60 000	65 000	65 000
Denmark					
Recovered (d)	4 386	4 751	4 660	4 223	4 142
Finland					
Pyrites	235 000	276 200	283 700	184 400	199 700
Recovered (c)	328 441	328 779	325 523	304 751	325 793
Recovered (d)	55 000	61 000	65 000	70 000	70 000
France					
Recovered (d)	795 600	710 400	698 400	622 345	616 234
Recovered (e)	229 000	196 000	150 000	127 000	124 000
Germany					
Recovered (c)	46 000	—	—	—	—
Recovered (d)	1 657 200	1 619 900	1 526 700	1 627 900	1 706 200
Recovered (e)	41 900	43 900	40 000	42 900	42 500
Greece					
Recovered (d)	157 000	162 000	160 000	162 000	162 000
Hungary					
Recovered (d)	52 000	51 000	35 000	65 000	50 000
Italy					
Recovered (c)	142 000	127 000	113 000	92 000	87 000
Recovered (d)	560 000	565 000	575 000	650 000	680 000
Lithuania					
Recovered (d)	49 824	48 515	67 094	74 276	61 135
Macedonia					
Recovered (c)	26 000	7 000	—	—	—
Netherlands					
Recovered (c)	124 000	131 000	137 000	141 000	111 000
Recovered (d)	373 000	408 000	410 000	440 000	455 000
Norway					
Recovered (c)	95 000	105 000	*105 000	*110 000	*110 000
Recovered (d)	19 000	20 000	18 000	19 000	20 000
Poland					
Frasch	760 320	762 689	821 489	801 799	800 200
Recovered (c)	*275 000	293 700	289 100	289 000	*290 000
Recovered (d)	22 777	23 384	23 767	22 193	21 567
Portugal					
Recovered	28 000	27 000	25 000	30 000	38 000
Romania					
Recovered	29 000	49 000	53 000	79 000	60 000
Russia					
Pyrites	261 000	357 000	286 000	304 000	304 000
Recovered (d)	5 589 969	5 804 740	5 909 958	6 301 000	6 346 000
Recovered (e)	458 000	523 000	572 000	640 000	695 000
Serbia					
Recovered	—	—	—	—	88 000
Serbia and Montenegro					
Recovered (c)	82 000	83 000	82 000	88 000	—
Slovakia					
Recovered (c)	5 000	5 000	5 000	5 000	5 000
Recovered (d)	61 000	60 000	65 000	65 000	65 000
Spain					
Recovered (c)	544 000	560 000	488 000	541 000	547 000
Recovered (d)	140 000	145 000	145 000	...	...

Production of sulphur and pyrites

tonnes (sulphur content)

Country	2002	2003	2004	2005	2006
Sweden					
Recovered (c)	177 600	180 200	185 800	180 000	180 000
Recovered (d)	51 065	62 454	62 238	59 839	68 391
Turkey					
Pyrites	34 000	28 000	20 000	55 000	59 000
Recovered (d) (e)	123 000	94 000	68 000	76 000	73 000
Ukraine					
Sulphur ore	124 000	142 000	136 000	139 000	133 000
United Kingdom					
Recovered (c)	66 400	4 800	—	—	—
Recovered (d)	125 000	115 000	120 000	124 000	115 000
Algeria					
Recovered (d)	19 000	19 000	20 000	20 000	19 000
Egypt					
Recovered (d)	78 000	78 000	78 000	78 000	80 000
Libya					
Recovered (d)	*50 000	*50 000	*50 000	*50 000	50 000
Namibia					
Pyrites	1 817	15 893	1 829	518	—
South Africa					
Pyrites	183 004	175 621	165 207	133 245	...
Recovered	179 186	264 077	179 776	220 254	220 000
Recovered	169 640	174 195	288 435	422 314	*420 000
Zambia					
Recovered (c)	52 000	52 000	52 000	52 000	75 000
Zimbabwe					
Pyrites	19 000	19 000	42 400	20 041	39 777
Canada					
Recovered (c)	1 109 000	992 000	1 089 000	1 057 632	1 160 620
Recovered (d)	7 816 000	8 036 000	7 995 795	7 914 616	8 352 917
Cuba					
Recovered (d)	*5 000	*5 000	*5 000	*5 000	*5 000
Mexico					
Recovered (c)	588 000	539 000	703 000	703 000	621 000
Recovered (d)	887 000	1 051 968	1 121 546	1 016 000	1 077 000
Netherlands Antilles					
Recovered (d)	25 000	23 000	28 000	40 000	40 000
Trinidad & Tobago					
Recovered (d)	14 000	29 000	17 000	16 000	15 000
USA					
Recovered (c)	772 000	683 000	739 000	711 000	*740 000
Recovered (d)	8 500 000	8 920 000	9 380 000	8 750 000	*8 500 000
Argentina					
Recovered (c)	23 000	23 000	23 000	23 000	23 000
Brazil					
Pyrites	22 620	19 246	24 174	19 618	20 954
Recovered (c)	284 184	285 824	279 631	266 817	297 539
Recovered (d)	77 185	90 332	91 804	112 093	117 203
Chile					
Recovered (c)	1 231 000	1 426 000	1 507 000	1 788 000	1 605 000
Colombia					
Recovered (d)	23 880	23 660	*24 000	*24 000	*24 000
Sulphur ore	60 162	73 024	97 586	64 660	30 018
Ecuador					
Recovered (d)	*20 700	*20 700	*20 700	*20 700	*21 000
Sulphur ore	*4 000	*4 000	*4 000	*4 000	*4 000
Peru					
Recovered (c)	*60 000	*60 000	*60 000	*60 000	...
Venezuela					
Recovered (d)	570 000	560 000	730 000	950 000	950 000

Production of sulphur and pyrites

tonnes (sulphur content)

Country	2002	2003	2004	2005	2006
Abu Dhabi					
Recovered (d)	1 900 000	1 925 000	1 926 000	2 060 000	2 045 000
Bahrain					
Recovered (d)	71 000	63 507	74 850	71 518	64 565
China					
Pyrites	2 766 000	3 974 000	4 029 000	4 011 000	3 986 500
Recovered	2 400 000	2 637 000	3 070 000	3 195 000	3 588 000
Sulphur ore	450 000	700 000	827 000	950 000	1 000 000
India					
Recovered (c)	458 000	539 000	539 000	637 000	801 000
Recovered (d) (e)	326 000	451 000	501 000	576 000	801 000
Indonesia					
Recovered (c)	196 000	212 000	172 000	212 000	168 000
Recovered (d)	95 000	95 000	100 000	105 000	105 000
Iran					
Recovered (d)	1 200 000	1 310 000	1 400 000	1 440 000	1 530 000
Iraq					
Recovered (d)	300 000	150 000	100 000	100 000	100 000
Israel					
Recovered (d)	36 000	45 000	42 000	44 000	42 000
Japan					
Recovered (b) (c)	1 592 000	1 528 000	1 545 000	1 583 000	1 679 000
Recovered (d)	1 865 424	1 952 000	1 894 000	1 972 000	1 950 000
Kazakhstan					
Recovered (c)	261 000	327 000	351 000	235 000	*235 000
Recovered (d)	1 600 000	1 585 000	1 625 000	1 590 000	*1 650 000
Korea, Dem. P.R. of					
Pyrites	18 000	18 000	18 000	18 000	18 000
Recovered (c)	16 000	16 000	16 000	16 000	16 000
Korea, Republic of					
Recovered (c)	753 000	747 000	796 000	861 000	899 000
Recovered (d)	660 000	660 000	660 000	660 000	660 000
Kuwait					
Recovered (d)	634 000	714 000	682 000	836 000	742 000
Oman					
Recovered (d)	*30 000	*30 000	*30 000	*30 000	*30 000
Pakistan					
Recovered (a)	22 580	19 402	23 873	24 158	24 730
Philippines					
Recovered (c)	154 000	162 000	163 000	163 000	180 000
Recovered (d)	30 000	30 000	40 000	45 000	45 000
Qatar					
Recovered (d)	250 000	272 274	307 187	450 000	450 000
Saudi Arabia					
Recovered (d)	2 364 000	2 179 000	2 249 000	2 700 000	2 975 000
Singapore					
Recovered (d)	180 000	180 000	215 000	250 000	250 000
Syria					
Recovered (d)	30 000	30 000	34 996	36 074	43 000
Taiwan					
Recovered	212 343	225 006	222 670	267 790	245 789
Thailand					
Recovered (c)	46 000	46 000	90 000	88 000	46 000
Recovered (d)	170 000	170 000	200 000	200 000	200 000
Uzbekistan					
Recovered (c)	163 000	163 000	163 000	163 000	163 000
Recovered (d)	360 000	360 000	360 000	345 000	345 000

Production of sulphur and pyrites

tonnes (sulphur content)

Country	2002	2003	2004	2005	2006
Australia					
Recovered (c)	899 000	863 000	850 000	915 000	915 000
Recovered (d)	60 000	60 000	60 000	60 000	60 000
New Zealand					
Recovered	26 000	26 000	21 000	29 000	29 000
World Total					
Pyrites	3 500 000	4 900 000	4 900 000	4 700 000	4 600 000
Frasch	800 000	800 000	800 000	800 000	800 000
Recovered	55 200 000	56 600 000	58 400 000	60 200 000	61 700 000
Sulphur ore	600 000	900 000	1 100 000	1 200 000	1 200 000

Note(s):-

- (a) Years ended 30 June of that stated
- (b) Including S content of sulphur ore
- (c) From metal sulphide processing
- (d) From petroleum refining and/or natural gas
- (e) Other

Production of talc

tonnes

Country	2002	2003	2004	2005	2006
Austria	138 195	137 596	136 305	166 569	159 447
Finland	477 229	501 658	528 943	508 169	547 146
France	359 000	394 000	402 000	416 000	*400 000
Germany	*8 000	3 859	...	...	...
Greece	670	500	200	250	*250
Italy	*80 000	*80 000	88 671	99 570	*100 000
Macedonia	4 662	3 271	4 350	1 955	1 025
Norway	43 000	48 000	32 000	34 000	*34 000
Portugal	8 279	5 460	6 231	5 362	5 517
Romania	7 310	10 082	9 725	6 760	2 967
Russia	93 841	129 888	154 138	*150 000	*150 000
Slovakia	2 290	4 200	7 100	200	—
Spain					
Talc	108 312	101 739	107 829	110 015	100 000
Pyrophyllite	...	900	700	700	...
Sweden	20 000	7 000	8 000	7 000	6 000
United Kingdom	6 194	6 494	3 881	6 000	4 000
Egypt (d)	45 529	*40 000	50 210	54 609	*55 000
Morocco					
Talc	6 708	1 959	*2 000	*2 000	2 000
Pyrophyllite	33 686	28 338	...	...	...
South Africa					
Talc	2 511	6 719	8 141	8 469	10 966
Pyrophyllite	15 587	14 350	28 987	60 267	74 886
Zimbabwe	1 024	196	—	—	—
Canada	93 000	87 000	81 000	70 000	68 000
Guatemala	...	1 585	2 863	16 131	526
Mexico	111 622	114 870	101 896	64 827	40 535
USA	828 000	840 000	833 000	856 000	*880 000
Argentina					
Talc	1 643	1 700	7 620	(b) 21 053	(b) 23 113
Pyrophyllite	2 341	4 525	12 594	...	...
Brazil (b)	348 000	369 000	409 946	413 340	389 391
Chile	563	840	722	886	704
Colombia (b)	*15 000	*15 000	*15 000	*15 000	*15 000

Production of talc

tonnes

Country	2002	2003	2004	2005	2006
Peru					
Talc	10 685	10 791	8 312	14 251	14 618
Pyrophyllite	9 514	12 291	14 282	10 100	0
Uruguay	816	1 095	1 042	1 131	1 544
Bhutan	23 118	23 101	39 797	42 791	*45 000
China	2 500 000	2 600 000	2 700 000	2 700 000	2 500 000
India					
Pyrophyllite (e)	147 233	176 240	271 225	181 328	145 921
Steatite (e)	688 135	726 398	684 440	627 216	655 407
Iran (a)	60 872	65 833	108 541	70 600	*70 000
Japan					
Talc	22 142	24 328	18 253	25 491	*25 000
Pyrophyllite	416 188	408 435	405 222	351 111	*350 000
Korea, Dem. P.R. of	*50 000	*50 000	*50 000	*50 000	*50 000
Korea, Republic of					
Talc	37 863	47 911	79 313	83 471	64 118
Pyrophyllite	889 961	912 285	827 895	885 559	677 465
Nepal (c)	2 621	6 905	3 435	5 832	6 648
Pakistan (d)	53 572	65 813	52 483	20 564	21 065
Taiwan	27	466	410	—	—
Thailand					
Talc	1 702	8 501	12 592	10 270	4 373
Pyrophyllite	103 496	73 556	108 691	177 684	131 843
Vietnam					
Pyrophyllite	*6 000	*8 000	*10 000	*12 000	*14 000
Australia (d)					
Talc	160 741	165 980	123 080	151 582	...
Pyrophyllite (d)	868	—	—	—	—
World Total	8 100 000	8 300 000	8 600 000	8 600 000	8 000 000

Note(s):-

- (a) Years ended 20 March following that stated
- (b) Including talc, agalmatolite and pyrophyllite
- (c) Years ended 15 July of that stated
- (d) Years ended 30 June of that stated
- (e) Years ended 31 March following that stated

Production of tantalum and niobium minerals

tonnes

Country	2002	2003	2004	2005	2006
Burundi					
Columbite-tantalite	72	24	23	43	16
Congo, Democratic Republic					
Columbite-tantalite	*130	*130	*130	*130	120
Ethiopia					
Tantalite	55	58	71	93	109
Madagascar					
Columbite	—	...	40	...	...
Mozambique					
Tantalite	47	189	712	281	240
Nigeria					
Tantalite	*25	*25	*25	*25	*25
Rwanda					
Columbite-tantalite	96	128	63	63	65
Uganda					
Columbite-tantalite	6	16	0	0	...
Zimbabwe					
Columbite-tantalite	26	231	27	—	—
Canada					
Pyrochlore	*7 800	*7 600	*8 000	*8 000	*8 000
Tantalite	215	203	209	233	204
Brazil					
Pyrochlore	*60 000	*66 000	*79 000	*146 000	*175 000
Columbite-tantalite	*5 800	*6 200	*6 500	*6 600	*5 400
China					
Columbite-tantalite	*350	*350	*350	*350	*350
Malaysia					
Struverite	2 298	2 619	121	552	93
Australia					
Tantalite	*2 300	*2 300	*2 400	*2 500	*1 400
World Total concentrates	79 200	86 100	97 700	164 900	191 000
Nb content	*31 100	*29 800	*27 300	*42 700	*51 600
Ta content	*1 700	*1 800	*1 500	*1 600	*1 000

Note(s):-

- (1) Niobium and tantalum minerals are believed to be produced in Democratic Republic of the Congo, Namibia, Russia and South Africa.
- (2) The figures in this table refer to gross tonnage of tantalum and niobium concentrates
- (3) Tantalum is also recovered from tin slags and is believed to have accounted for approximately 20% of raw material supplied.

Production of tellurium metal

tonnes

Country	2002	2003	2004	2005	2006
Canada	39	40	69	11	11
USA	50	50	50	50	50
Peru	22	26	25	33	37
Japan	29	33	33	23	24

Note(s):-

- (1) In addition to the countries listed, Germany is believed to produce tellurium metal

Mine production of tin

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Portugal	345	203	200	243	25
Russia	5 200	5 400	5 300	5 100	*5 000
Burundi	—	9	—	—	78
Congo, Democratic Republic	1 450	2 600	6 800	7 600	7 200
Nigeria	789	891	1 374	*1 500	*1 500
Rwanda	197	300	547	500	*500
Bolivia	13 210	16 386	18 115	18 639	17 669
Brazil	12 023	12 217	12 202	11 739	9 528
Peru (a)	38 815	40 202	41 613	42 145	38 470
Burma	500	600	500	700	*700
China	*81 000	101 800	118 200	121 600	114 300
Indonesia	67 455	66 284	78 400	120 000	117 500
Kazakhstan	24	13	14	5	—
Laos	430	420	*400	*600	*600
Malaysia	4 215	3 358	2 745	2 857	2 398
Thailand	1 384	980	724	188	225
Vietnam	*1 700	*2 100	*3 500	*3 500	*3 500
Australia	7 078	3 819	1 306	2 713	1 478
World Total	236 000	258 000	292 000	340 000	321 000

Note(s):-

(a) Recoverable

Smelter production of tin

tonnes

Country	2002	2003	2004	2005	2006
Belgium	8 900	7 700	8 900	7 700	8 000
Russia	5 115	3 700	5 100	5 500	5 500
Nigeria	728	801	—	—	—
Bolivia (a)	10 976	12 836	13 627	13 841	*13 500
Brazil	11 538	10 761	11 512	8 986	8 780
Peru	35 828	39 181	40 624	36 733	40 495
China	81 800	98 100	115 300	121 800	129 400
Indonesia	58 800	62 500	86 900	78 404	80 933
Malaysia	30 887	18 211	33 900	37 782	*23 000
Thailand	17 500	15 200	20 800	31 600	27 540
Vietnam	1 565	1 915	2 356	2 510	2 500
Australia	791	597	467	594	572
World Total	264 000	272 000	339 000	345 000	340 000

Note(s):-

(1) Figures relate to both primary and secondary metal

(2) In addition to the countries listed, many countries produce small amounts of secondary metal

(a) Refined, including alloys

TITANIUM

Characteristics

Titanium is the ninth most abundant element in the Earth's crust. It is a hard, silver-coloured metal which is light, yet very strong. It has a high melting point (1668 °C), very high corrosion resistance, low coefficient of expansion, high electrical resistivity and is non-magnetic.

Ilmenite and rutile are the two predominant titanium minerals extracted commercially. Rutile (TiO₂) is a fairly pure form of titanium dioxide with 95-100 per cent TiO₂ while ilmenite (FeTiO₃) normally contains around 50 per cent TiO₂. Leucoxene is an alteration product of ilmenite which has high TiO₂ content, typically around 90 per cent.

Titanium mineral deposits are classified as primary rock deposits and sedimentary deposits. Primary rock deposits occur in massif-type anorthosites and layered mafic intrusions. Important anorthosite deposits include the Lac Allard deposit, Quebec, Canada and the Tellnes deposit in Norway. The layered mafic deposits are less commercially viable due to intergrowth of magnetite with the ilmenite.

Weathering of igneous rocks, chemical alteration of mineral grains, fluvial transportation, deposition and subsequent reworking of titanium minerals has created high-grade deposits of these heavy minerals on present and past river beds and, particularly, shorelines. Sedimentary deposits of this type, often called heavy mineral sands or black sands, are the predominant source of titanium and include the deposits of the Murray Basin, Australia; Richards Bay, South Africa; Sierra Leone and Sri Lanka.

Titanium dioxide is produced by either the chlorination of rutile, or of synthetic rutile produced from ilmenite, to form titanium tetrachloride which is then oxidised, or by the sulphation of ilmenite which is then hydrolysed to yield the dioxide. To produce metal, titanium tetrachloride is passed over a bath of molten magnesium which captures the chlorine to give a porous product called titanium sponge (the Kroll process). This is remelted into ingots. Ilmenite may also be processed by smelting to form titanium slag, an intermediate product that is then treated by the sulphate process

The US Geological Survey (Gambogi, 2008) estimates global reserves of titanium minerals at 730 million tonnes. The largest reserves are in China (mainly primary rock deposits), Australia (heavy mineral sands) and South Africa (heavy mineral sands).

Uses

Around 95 per cent of titanium is used as titanium dioxide (TiO₂) pigment. It is white, with good opacity, chemically and thermally stable, and non-toxic. The predominant market is as an additive in paint, both as a white pigment and an opacifier. It is also used as a pigment and opacifying agent in plastics, paper, coatings and inks. There are also non-pigment uses for titanium dioxide. Ultrafine particles can be transparent and scatter light, lending to its use as a functional filler in metallic paints and sun screen creams, for example. It is used in batteries and in the manufacture of a range of titanium chemicals.

The metal has a range of physical properties that make it useful in many applications. It is light, strong, and bio-compatible with the human body. It is therefore suitable for use in dental and surgical implants, such as pacemakers and

joint replacements, as well as jewellery and spectacle frames that do not cause skin irritation. Titanium metal and its alloys are used in aerospace – for both engines and airframes – as they are considerably lighter and stronger than steel. The most commonly-used titanium aerospace alloy contains six per cent aluminium and four per cent vanadium. High resistance to corrosion makes titanium a suitable metal to use in the manufacture of chemical process plant and in marine applications. It is used in sporting goods, such as golf clubs, and in architecture, e.g the Guggenheim Museum, Bilbao, Spain.

Ferrotitanium, which typically contains 70 per cent titanium, is used in the production of stainless steel as a deoxidiser and stabiliser, while other titanium alloys have a wide range of specialised uses including superconductors and shape-memory alloys.

Titanium minerals are used in fluxes for coating welding electrodes. Consumption is estimated at around 110 000 tonnes TiO₂, but future growth in demand may be limited as less is needed in the new continuous welding process (Murphy and Frick, 2006). Titanium minerals are also used as flux in iron and steel smelting and ilmenite, due to high density, may be used in drilling muds.

World production in 2006

In 2006, sixteen countries produced titanium minerals and total production was around 12.2 million tonnes. This comprised 11.6 million tonnes of ilmenite and 0.6 million tonnes of rutile and leucoxene. The total TiO₂ content is estimated as 6.1 million tonnes, representing an increase of 13 per cent on 2005 and a 22 per cent increase in five years.

Australia is the world's leading producer, with 2.4 million tonnes of ilmenite, 0.2 million tonnes of rutile and 0.1 million tonnes of leucoxene. Canada is the second largest producer and South Africa is third. The combined output of these countries makes up almost 60 per cent of world ilmenite production and 85 per cent of rutile/leucoxene.

Production restarted in Sierra Leone, after a decade of inactivity.

Prices

TiO₂ pigment average prices for the 2006 ranged from US\$1388 per tonne (Chinese exports, f.o.b.) to US\$2148 per tonne (European imports, c.i.f.). The prices in 2007, up to September 2007, averaged US\$1484 and US\$2246, respectively. Australian exports (f.o.b.) averaged US\$1877 in 2006 and US\$1902 for the first nine months of 2007 (TZM, 2007).

According to the Metal Bulletin database (Metal Bulletin, 2008), the price of rutile has varied little in recent years. Rutile, bulk concentrates, minimum 95 per cent TiO₂, f.o.b. Australia, is currently in the range US\$475–500. Ilmenite, bulk concentrate, minimum 54 per cent TiO₂, Europe, f.o.b., has been US\$75–85 since mid-2005.

Ferro-titanium prices (ferro-titanium 70 per cent; maximum 4.5 per cent Aluminium; Metal Bulletin free market US\$ per kg Titanium; d/d Europe) declined fairly steadily after two peaks of around US\$ 27-33 per kilogramme in 2005. Through 2006, the price fell from US\$17–18 to US\$14.8–15.3, and by the end of 2007 it was US\$7.65–8.1. As for metal, titanium

(TG100; 12 x 120 mm) Metal Bulletin free market sponge, is US\$20–25 per kilogramme, compared to US\$28–32 in mid-2005. Mineral Sands Report (July 2007) provided a lower spot price in June 2007, just US\$10 per kilogramme, and attributes this to a surplus of supply caused by several plant expansions now producing and new projects in China. There are no supply problems for lower quality metal, such as that produced in China. However, metal for high-specification uses, as required in aerospace, is currently in short supply although the situation is easing.

Industry events in 2007

During this year there were many reports of companies increasing production of titanium minerals, and manufacture of sponge and titanium dioxide. As with all commodities, the increasing demand from Asia provides the market for much of the growth.

In February, Tiwest, the largest integrated titanium minerals production and titanium dioxide pigment manufacturer with six sites in Western Australia, revealed plans to increase production capacity at their titanium dioxide plant. These expansion plans were in response to growth in China and its increasing demand for products containing titanium dioxide.

Mining Journal (2 March 2007) reported that Sumitomo Titanium Corporation was planning to invest US\$35.6 million to boost capacity in its titanium sponge plant in Japan. This is in addition to the US\$228 million that was reported six months earlier. Production capacity will increase from 24 000 tonnes to 38 000 tonnes per year, with completion planned for 2009.

Baoji Titanium Industry Co., China's largest titanium producer, plans to double its annual production to 10 000 tonnes by 2010 (Mining Journal, 10 August 2007).

The Titanium Metals Corporation (Timet) announced plans to construct a new titanium sponge facility in the USA to provide 10 000 to 20 000 tonnes of capacity. These plans now appear to have been shelved following the agreement of a long-term supply agreement with Toho Titanium, Japan (Mineral Sands Report, December 2007).

Looking to the Chinese and Russian markets, Aricom commenced mining at their Kuranakh ilmenite and titanomagnetite operation in the far east of Russia in October, with processing scheduled to start in December. Estimated titanium dioxide reserves at Kuranakh are 3.8 million tonnes. The company also moved from the AIM³ to the Main Market of the London Stock Exchange.

The world's second largest supplier of titanium dioxide was sold to the ninth largest supplier for US\$1.2 billion. Millennium Inorganic Chemicals, a subsidiary of Lyondell Chemical was bought by Saudi Arabia's National Titanium Dioxide Company (also known as Cristal). The combined company operates nine manufacturing plants in six countries.

Most of the news in exploration and development of new operations came from Africa and Australia. The BHP Billiton titanium slag project at Corridor Sands in Mozambique, acquired in its takeover of WMC Ltd, is in development. Mining Journal (2 March 2007) reported that the scale of the project was being reduced as the original plan was uneconomic, although it may still cost up to US\$2 million.

Kenmare's Moma Mine, located on the coast of Mozambique, commenced production on 25 April 2007. Project financing has been based on reserves of 16.4 million tonnes of ilmenite, 0.5 million tonnes rutile and 1.3 million tonnes zircon. The mine has the capacity to produce 800 000 tonnes of ilmenite, 21 000 tonnes of rutile and 56 000 tonnes of zircon per year for at least 20 years and supply eight per cent of global titanium feedstocks (Kenmare, 11 January 2008).

In May, Titanium Resources Group Ltd placed new shares on the London Stock Exchange for trading on AIM, raising approximately £17.6 million (US\$35.2 million). Part of the proceeds was used in upgrading and expanding Sierra Rutile. In November the company announced the commissioning of the second dredge at the Sierra Rutile Mine, in Sierra Leone, which recommenced production in 2006. The second dredge is expected to double the company's annual rutile production capacity to approximately 200 000 tonnes per annum. Construction has started on a third dredge with the capacity to produce a further 40 000 tonnes annually and is expected to commence production in mid-2008. The mineral separation plant is being upgraded and this should increase total processing capacity for rutile production to 300 000 tonnes annually from January 2008.

Iluka Resources Ltd commenced commercial production from its Murray Basin operations in Victoria, Australia, in the first quarter of the year. It is planned that the production of rutile and zircon will, in time, offset the decline in production in Western Australia and cessation of production in Florida and Georgia. The company has also discovered a new prospect — the Typhoon prospect — which is very close to other discoveries in the Eucla Basin of South Australia, and still further discoveries and extensions to existing deposits, particularly in the Murray Basin, have resulted from continuing exploration. Other mining companies also have active exploration programmes in the Eucla and Murray Basins.

Jinchuan Group Ltd. has invested US\$10.9 million in Tiomin Resources Inc., increasing Jinchuan's interest in Tiomin to 20 per cent, with an option to increase its interest to 30 per cent. This investment will partly be used to develop the Kwale mineral sands project in Kenya. Earlier in the year Tiomin reported that the development of the Kwale project was on hold due to delays and rising costs, and that they were not permitted to draw on the project's US\$155 million debt facility due to economic and other issues related to the project.

Tiomin anticipates completing the resettlement of farmers displaced by the project by the end of the first quarter. The Company will work towards the evaluation of substantial technical and contractual cost saving measures to improve the economics of the Kwale project. The project development is expected to be on hold for a minimum of seven months but Tiomin expects that strong product prices (for zircon and rutile) and reduced capital spending will revive lender interest at the appropriate time.

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³AIM is the London Stock Exchange's international market for smaller growing companies from any country and any industry sector.

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Production of titanium minerals

tonnes

Country	2002	2003	2004	2005	2006
Norway					
Ilmenite	837 000	859 000	866 700	806 800	850 000
Ukraine					
Ilmenite	*550 000	*610 000	*600 000	*550 000	*600 000
Rutile	*100 000	*100 000	*100 000	*90 000	*100 000
Egypt					
Ilmenite	125 000	125 000	125 000	125 000	*125 000
Sierra Leone					
Ilmenite	—	—	—	—	13 819
Rutile	—	—	—	—	73 600
South Africa					
Ilmenite (b)	*1 649 000	*1 581 000	1 730 000	1 904 000	*2 000 000
Rutile	*140 000	*100 000	*100 000	*130 000	*121 000
Canada					
Ilmenite (a) (b)	*2 100 000	*1 900 000	*2 100 000	*2 100 000	*2 400 000
USA	400 000	500 000	*500 000	*500 000	*500 000
Brazil					
Ilmenite	174 382	120 160	133 000	127 142	*130 000
Rutile	2 645	*2 500	*3 000	2 782	*3 000
China					
Ilmenite	*840 000	*840 000	*840 000	*1 015 000	*1 300 000
India					
Ilmenite (c)	478 717	589 829	632 025	704 243	*690 000
Rutile (c)	14 531	19 646	19 648	20 299	*20 000
Korea, Republic of					
Ilmenite	142 726	114 660	150 744	157 433	179 982
Malaysia					
Ilmenite	106 198	95 148	61 471	38 195	45 649
Rutile	7 059	18 472	27 308	5 509	16 921
Sri Lanka					
Ilmenite	—	—	1 335	36 303	57 034
Rutile	—	—	2 798	8 162	2 280
Vietnam					
Ilmenite	*170 000	*220 000	*325 000	*360 000	*360 000
Rutile	*500	*500	*500	*500	*500

Production of titanium minerals

tonnes

Country	2002	2003	2004	2005	2006
Australia					
Ilmenite	2 092 000	2 006 000	1 934 000	2 034 000	2 378 000
Rutile	219 000	173 000	162 000	177 000	232 000
Leucoxene	38 000	57 000	44 000	62 000	133 000
World Total					
Ilmenite (wt of concs)	9 700 000	9 600 000	10 000 000	10 500 000	11 600 000
Rutile (wt of concs)	484 000	414 000	415 000	434 000	569 000
All forms (TiO ₂ content)	*5 000 000	*4 900 000	*5 100 000	*5 400 000	*6 100 000

Note(s):-

(1) The figures in this table refer to gross tonnage of titanium concentrates

(2) Some ilmenite is converted to synthetic rutile in Australia, India, Japan, Taiwan and USA

(a) Canada produces some ilmenite which is sold as such and not processed into slag, but tonnages are small

(b) Processed into slag. In 2006 South Africa produced an estimated 1 100 000 tonnes (85% TiO₂) and Canada produced an estimated 1 000 000 tonnes (80-95% TiO₂)

(c) Years ended 31 March following that stated

Mine production of tungsten

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Austria	1 377	1 381	1 335	1 280	1 153
Portugal (c)	693	715	746	816	780
Russia (c)	*3 400	*3 900	*3 000	*4 400	*4 500
Rwanda	153	78	120	*120	*120
Uganda	52	2	63	36	75
Canada	2 295	3 654	—	484	2 561
Bolivia	376	441	403	530	870
Brazil (a)	24	30	293	557	525
Burma (b)	84	96	107	168	*170
China	35 927	36 185	59 947	*61 000	*62 000
Korea, Dem. P.R. of	*600	*600	*600	*600	*600
Kyrgyzstan	*100	*100	*100	*100	*100
Mongolia	35	12	48	54	85
Thailand (c)	53	390	337	622	546
Uzbekistan	250	300	300	*300	*300
Australia (d) (e)	—	—	...	44	13
World Total	45 400	47 900	67 400	71 100	74 400

Note(s):-

(a) Mainly scheelite

(b) Including tungsten content of tin-wolframite concentrates

(c) Wolframite and scheelite

(d) Scheelite

(e) Years ended 30 June of that stated

URANIUM

Characteristics

Uranium is a very dense, metallic element which is naturally radioactive. It spontaneously decays, through a long series of alpha or beta particle emissions, ultimately forming the stable element lead.

It occurs in a variety of different geological environments. The largest economic deposits are in sedimentary rocks, but deposits are also found in hydrothermal, metamorphic, surficial and igneous settings. Under oxidizing conditions it exists in a highly soluble form and is therefore very mobile. However, under reducing conditions, where oxygen is depleted, it converts to an insoluble form and is precipitated. This is the process that usually results in concentrations of uranium that are sufficient for economic extraction. The most common uranium mineral is uraninite (uranium oxide), known as pitchblende when in its massive form. Lesser amounts of the silicate brannerite and the uranium titanate, coffinite, also occur in economic deposits, in association with uraninite. The product shipped from all uranium mines is purified solid U_3O_8 , known as 'yellowcake'. This is produced by leaching either crushed or in situ ore, followed by solvent extraction, precipitation, and calcining.

Uranium occurs as several isotopes, of which the most abundant are uranium-238 (about 99.3 per cent of natural uranium) and uranium-235 (0.7 per cent of natural uranium). In most nuclear power plants it is uranium-235 that is required and hence uranium often undergoes enrichment prior to being made into fuel.

Uses

Uranium's main use comes from the energy that is released when an atom of uranium is split by nuclear fission. This is caused by the uranium atom being struck by, and absorbing, an extra neutron. Each time an atom undergoes fission, additional neutrons are also released and these can cause a chain reaction to occur if they collide with other uranium atoms.

Over 95 per cent of uranium is used in the production of electricity in nuclear power stations. The remainder is used for the propulsion of ships, research, desalination and military ordnance.

Most nuclear power stations use the fission of uranium-235 as a heat source for converting water into steam. The steam is then used to propel turbines, which generate electricity, in the same way that fossil fuels are used in conventional power stations. The main contrast is that one kilogram of uranium-235 produces approximately three million times more energy than a similar weight of coal.

The International Energy Agency (IEA) estimates that 18 235 TWh of electricity were produced around the world in 2005. Of this, 15.2 per cent was produced by nuclear power, compared to 40.3 per cent produced by coal (IEA, 2007). However, some countries are far more reliant on nuclear power to generate their electricity than this overall figure would suggest. For example, in 2005, France produced 79 per cent of its electricity requirements from nuclear power, compared to 20 per cent in the UK. In China, the figure was only two per cent, but significant growth in nuclear power is anticipated due to the number of new reactors under construction or planned.

In November 2007, there was a total of 439 nuclear reactors generating electricity in the world, with another 33 under construction. This includes seven in Russia, six in India and five in China. A further 94 reactors were 'on order or planned', including 30 in China, and 222 reactors were 'proposed' of which 86 were in China (WNA, 2007).

In addition to nuclear reactors for electricity production, there are currently around 280 reactors used for research purposes in 56 countries. These are used to create neutron beams suitable for studying the structure and dynamics of materials at atomic level. They are also used to produce radioisotopes for medical applications such as cancer treatment.

Nuclear reactors have also been used to propel ships since the 1950s. They are particularly useful in submarines and ships operating in arctic conditions where they provide considerably more power than other fuels, and enable long periods at sea without the need to refuel. Eleven of the USA's aircraft carriers are also propelled in this way.

Desalination is an energy intensive process and in this context nuclear power is often cost-competitive with other sources of power. In several countries desalination takes place alongside electricity generation and there is potential for this combined method to increase.

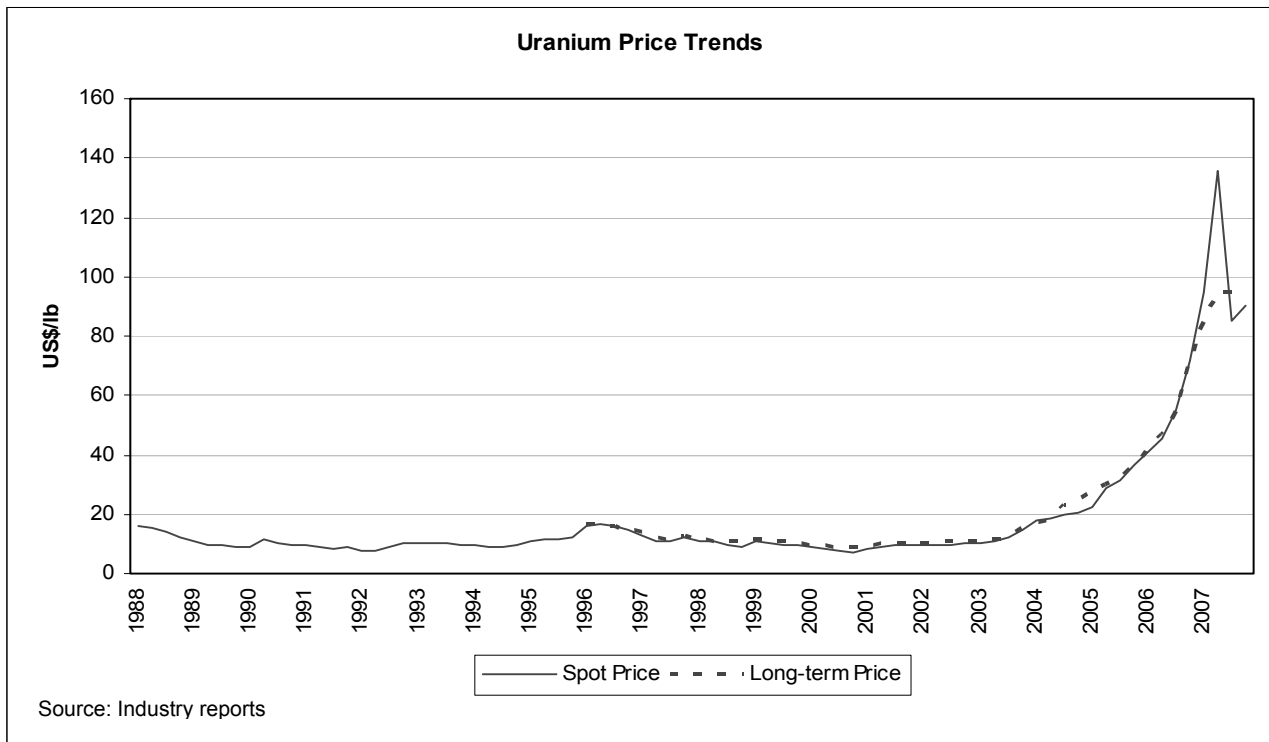
Uranium has long been a sensitive political topic because highly enriched uranium (which contains over 90 per cent of uranium-235) can be used in weapons. No uranium used in power stations is capable of use in a weapon because it contains either natural or low-enriched uranium (generally a maximum of 5 per cent of uranium-235). However, low-enriched uranium can be converted into highly enriched uranium with further enrichment.

To prevent the spread of nuclear weapons, the International Atomic Energy Authority (IAEA) has operated a series of safeguards since 1970 under the Nuclear Non-Proliferation Treaty. A large number of nations have signed the Treaty, including the five countries who have officially declared that they have nuclear weapons: USA, Russia, China, UK and France. Three other countries are known to hold them: India, Pakistan and Israel, but these countries have not signed the Treaty. North Korea withdrew from the Treaty in 2003 and claimed to have tested a nuclear weapon in 2006. Subsequent negotiations resulted in the closure of their nuclear facilities in 2007. Another country causing concern is Iran. It is a signatory of the Treaty and insists that the construction of facilities in the country is for peaceful purposes. The work of the IAEA in attempting to enforce safeguards under the Treaty is often difficult and politically sensitive.

World production in 2006

The total mined production of uranium (metal content) fell slightly in 2006 compared to 2005, reversing an upward trend of recent years. This was largely as a result of production difficulties encountered by the two largest-producing countries, Canada and Australia.

Canada continued to be the largest producer of mined uranium, with 25 per cent of the world's total, despite a fall in production from more than 11 000 tonnes to less than 10 000 tonnes. Australia was again in second place, with 19 per cent of the world total, despite a fall from over 9 000 tonnes to less than 8 000 tonnes. Kazakhstan remained in third place, with 14 per cent of the world total, and continued their steady



increase in production to more than 5 000 tonnes. Since 2002, production in Kazakhstan increased by 89 per cent.

Other significant producing countries include Russia, Niger, Namibia, USA and Uzbekistan. Russia's production levels dropped in 2006 compared to 2005 and they were overtaken by production in Niger, which has risen by 12 per cent since 2002. Namibia's production has fallen for the past two years; however, this is expected to change in 2007 due to the opening of a new mine. Production in the USA has risen over the past four years, reversing a long term decline in uranium mining but this is still far short of the historical production levels from the 1970s. Uzbekistan saw a slight reduction in production in 2006, but previously mine output increased by 41 per cent between 2002 and 2005.

Prices

Over 80 per cent of uranium is sold under long-term contracts (three to seven year terms), however, a spot market has been in existence for several years and this is frequently referred to when negotiating prices for long-term contracts. From 1988 to 2004 spot market prices were very low, rising to a mere US\$20/lb by the end of 2004. Since then, however, they have risen sharply reaching a height of US\$138/lb in June 2007. This was followed by an equally sharp fall in the latter part of 2007, before stabilising at around US\$90/lb at the end of the year.

The long-term industry average price has risen more slowly, but still significantly, from a low of just over US\$9/lb in 2000 to around US\$95.00 at the end of 2007.

Demand for uranium, for electricity generation, continues to be much higher than current mine production levels, with the shortfall being supplied by reprocessing, stockpiles or the conversion of weapons-grade uranium into fuel for power stations. Concerns over continuity of supply resulted in the increase in prices during the first part of the year. This was due in part to an increase in the number of nuclear reactors proposed or planned as a result of current international efforts to reduce carbon dioxide emissions. However, part of the increase during mid-2007 was probably caused by speculation

in the market. During the year, market speculators withdrew their interest and the concerns over security of supply in the near-term were relaxed, which both contributed to a price fall.

Industry events in 2007

March saw the first shipment of yellowcake (uranium oxide U_3O_8) from the new Langer Heinrich Mine in Namibia. Langer Heinrich started production in late 2006 and is the first new uranium mine in the world for a decade, commissioned by Paladin Resources Ltd in 2002. Although commissioning difficulties reduced the production for 2007 from the 2.6 million lbs per year forecast, the mine is expected to increase production during 2008 (Lawson, 2007a; Mining Magazine, 2007; Haycock, 2007a; Murray, R, 2007).

Namibia's other uranium mine, Rössing, which has been operating since the 1970s, announced this year that an investment of US\$112 million would ensure that the life of the mine will be extended from 2016 to 2021. It is also expected to increase output by 12.5 per cent in 2008 (Mineweb, 2007; Mining Journal, 2007a).

Also in Africa, the strong uranium price has encouraged significant exploration in Malawi, Zambia and Botswana, as well as at other locations in Namibia. Paladin Resources Ltd has successfully resolved the various concerns raised by six Civil Society Organisations regarding its proposed uranium mine at Kayelekera in Malawi. The mine is due to come on stream towards the end of 2008 or early 2009 (Jomo, 2007).

The world's largest uranium mining company, Cameco, has experienced a number of setbacks in 2007. Their developing mine, at Cigar Lake in Canada, experienced a rock fall and flooding in October 2006 and remediation has proved to be difficult, resulting in a delay to production start up into 2011 (Kosich, 2007a; Lawson, 2007b; Mining Journal, 2007b). A problem of water inflow into the Rabbit Lake mine in November caused production to be suspended, although this was quickly rectified and the mine was back in production by the end of the year (Kosich, 2007b). Despite these difficulties, Cameco is predicted to increase revenue when their final 2007

results are announced, largely as a result of the high uranium price.

Difficulties were also experienced at the Ranger mine in Northern Territory, Australia during the first quarter of 2007 as a result of severe weather that caused flooding and reduced production (Mining News, 2007). However, Energy Resources Australia, who operate the mine, reported much improved production for the remainder of the year.

In April, Australia's Labour party at national level voted to change its 'no new mines' policy for uranium mining. However, the state premiers for Queensland and Western Australia are still opposed to mining in those states (Louthean, 2007a; Garvey, 2007). Following the recent election, the Labour party now forms the Federal Government.

Australia's fourth uranium mine is likely to be at Honeymoon in South Australia. The in-situ leach mine, owned by Uranium One, is expected to start production in 2008 (Louthean, 2007b). This is likely to be followed by a fifth mine at Four Mile, also in South Australia, owned by a partnership of Alliance Resources and Quasar Resources. Additional resources have been outlined both at Four Mile East and Four Mile West (Jacoby, 2007), and production is expected by mid-2009.

The high uranium price has also prompted proposals to extract the metal from some unusual sources, such as phosphorite resources in Morocco (Mukumbira, 2007) or former mine tailings in South Africa (Haycock, 2007b).

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Mine production of uranium

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Czech Republic	477	458	435	420	383
France	12	—	—	—	—
Germany	221	104	77	80	65
Portugal	2	—	—	—	—
Romania	90	90	90	*90	*90
Russia	2 900	3 150	3 280	3 431	3 262
Ukraine	*800	*800	*800	*800	*800
Namibia	3 058	2 416	3 159	2 855	2 782
Niger	3 076	3 143	3 273	3 093	3 434
South Africa	846	758	752	674	542
Canada	11 607	10 456	11 599	11 627	9 862
USA	901	*770	878	1 034	1 579
Brazil	270	310	300	110	190
China	*730	*750	*750	*750	*750
India	*230	*230	*230	*230	177
Kazakhstan	2 800	3 300	3 719	4 357	5 279
Pakistan	*38	*45	*45	*45	*45
Uzbekistan	1 860	1 770	2 035	2 629	2 270
Australia	7 146	7 633	9 010	9 516	7 606
World Total	37 100	36 200	40 400	41 700	39 100
World Total (U ₃ O ₈ equivalent)	43 800	42 700	47 700	49 200	46 100

Note(s):-

(1) Excluding uranium production from decommissioning operations in France, Germany and Spain

Mine production of vanadium

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Russia	30 306	18 099	24 277	*24 000	*24 000
South Africa	25 227	27 172	23 303	22 604	*20 000
China	*13 200	*14 000	*16 000	*17 000	*17 500
Kazakhstan	*1 000	*1 000	*1 000	*1 000	*1 000
Australia	3 146	694	220	—	—
World Total	73 000	61 000	65 000	65 000	63 000

Note(s):-

(1) This table includes vanadium in slag products but excludes vanadium recovered as a byproduct of the refining and burning of heavy oils

Production of vermiculite

tonnes

Country	2002	2003	2004	2005	2006
Russia	*25 000	*40 000	*30 000	*30 000	*30 000
Egypt (c)	380	*400	*400	6 655	*6 600
South Africa	210 297	182 802	196 893	209 801	197 765
Uganda	664	1 724	2 688	2 574	3 512
Zimbabwe	21 494	13 260	27 150	23 045	13 421
USA (a)	*100 000	*110 000	*100 000	*100 000	*100 000
Argentina	1 050	1 124	1 293	1 403	1 585
Brazil	23 000	26 000	26 000	28 000	30 000
China	*80 000	*90 000	*100 000	*100 000	*100 000
India (b)	5 499	4 493	3 377	4 774	9 634
Iran	2 845	...	...	—	...
Japan	*6 200	*6 200	*6 000	*6 000	*6 000
Australia (c)	6 696	13 436	9 676	8 769	9 392

Note(s):-

(1) In addition to the countries listed Malawi is believed to produce vermiculite

(a) Sold or used by producers

(b) Years ended 31 March following that stated

(c) Years ended 30 June of that stated

Production of wollastonite

tonnes

Country	2002	2003	2004	2005	2006
Finland	17 400	17 300	16 763	15 950	16 200
Spain	...	...	...	30 000	30 000
Namibia	742	585	406	253	55
Mexico	42 756	31 234	28 224	27 132	44 280
USA	*150 000	*120 000	*120 000	*120 000	*125 000
China	330 000	340 000	345 000	350 000	350 000
India (a)	178 298	150 814	170 292	128 582	132 231

Note(s):-

(1) In addition to the countries listed, Turkey is believed to produce wollastonite

(a) Years ended 31 March following that stated

ZINC

Characteristics

Zinc is the 23rd most abundant element in the Earth's crust. Zinc is a blue-grey metal; the freshly cut surface having a typical metallic lustre, which quickly tarnishes to dull grey when exposed to air, due to oxidation. It is moderately reactive and burns with a bright bluish-green flame in air. It reacts with both acids and alkalis. Malleable between 100°C to 210°C, above 210°C zinc becomes brittle and can be powdered. Zinc is non-magnetic.

Zinc does not occur in nature in the form of native (free) metal. The most commonly found ore minerals are sphalerite (zinc sulphide, ZnS), also known as zinc blende, and its variety marmatite (zinc sulphide containing some iron sulphide, (Zn,Fe)S), from which over 95 per cent of the world's zinc is produced. Other economically important zinc minerals include smithsonite or zincspar (ZnCO₃), willemite (Zn₂SiO₄) and hemimorphite (Zn₄Si₂O₇(OH)·2H₂O), which may occur in the near-surface weathered or oxidised zone of an orebody. Less important are metamorphically-formed zinc oxide ores such as the spinel, franklinite (Zn, Fe, Mn)(Fe, Mn)₂O₄) or zincite (ZnO).

Zinc deposits are formed by deposition from hydrothermal brines and are generally polymetallic, commonly including economic levels of copper, lead, silver, cadmium, bismuth, tin and gold. Economic levels of barite and fluorite may also be present. Zinc ore deposits are widely spread throughout the world and mining is currently carried out in more than 50 countries. China, Australia, USA, Canada, Kazakhstan and Mexico have the largest zinc reserves (Cohen, 2007).

Before the zinc can be recovered from ore concentrate, the sulphur content must be removed by sintering. The concentrate is brought to a temperature of more than 900°C converting the sulphide into the more active zinc oxide and sulphur is driven off as sulphur dioxide gas which subsequently is converted to sulphuric acid, an important commercial by-product. The zinc can then be extracted from the calcine either by leaching and subsequent electrolysis or by smelting in a blast furnace. Today over 90 per cent of zinc is produced in electrolytic plants. Smelting is extremely energy intensive but has the advantage that it allows simultaneous production of lead, commonly associated with zinc in ore bodies. Electrolytic recovery produces >99.9 per cent pure zinc requiring no subsequent refining (American Zinc Association, 2008).

Total world reserves of zinc are 180 million tonnes of which Australia holds 42 million tonnes, China 33 million tonnes and Peru 18 million tonnes (USGS). At present, approximately 70 per cent of the zinc produced worldwide is primary and 30 per cent is from recycled or secondary (including manufacturing scrap) sources. The level of recycling is increasing and over 80 per cent of the zinc available for recycling is recycled (International Zinc Association, 2008).

Uses

Current global uses of refined zinc (ILZSG, 2008):

- galvanizing (47%)
- brass and bronze (19%)
- zinc alloys (for die-casting industry etc.) (14%)
- chemicals (9%)
- semi-manufactures (8%)

From these first-use manufactures zinc is transformed into in a broad range of products. The main application areas are in construction (45 per cent), transport (25 per cent), consumer goods and electrical appliances (23 per cent), and general engineering (7 per cent). Zinc's ability to protect iron from corrosion in galvanising determines its most important use, and most of this product goes to supply the construction industry. Overall, about 75 per cent of zinc used is used as metal. The remainder is used zinc compounds mainly by the rubber, chemical, paint, and agricultural industries (International Zinc Association, 2008).

World production in 2006

World zinc production (slab zinc) in 2006 was 10.8 million tonnes. This was a six per cent increase on 2005. Production increased steadily during the period 2002 to 2006, showing an overall increase of 11 per cent, although with a slight dip (two per cent) from 2004 to 2005. China remained the top-producing country with 3.2 million tonnes in 2006. This represents a 14 per cent increase on 2005 and a 45 per cent increase since 2002. Canada was the second-largest producer with 0.82 million tonnes and the Republic of Korea third, with production of 0.67 million tonnes.

Prices

Throughout 2006 zinc was one of the best-performing metals on the London Metals Exchange (LME), achieving a record high of US\$4580 per tonne on 9 November. The rapid price rise began in July 2005, climbing to previous record highs set during 1997 by the beginning of 2006 (see figure). This rapid price increase was attributed to several factors: a 15-year low in LME stocks of zinc, increased world demand, tightening world supply, and investment buying. World mine and refinery production both increased in 2006, driven primarily by China and India. Excluding China, world refined zinc consumption outpaced supply. After an initial decline in 2007, the price staged three recoveries peaking at US\$4120 per tonne on 9 May, US\$3820 per tonne on 24 July and finally US\$3161 per tonne on 15 October 2007. The high prices achieved in 2006 resulted in the reopening and expansion of zinc mines worldwide during 2007. This resulted in a supply surplus with corresponding concerns and falling prices in the second half of the year (Giglio, 2007).

This decline in zinc prices also corresponds to a period of sharp decline in physical premiums⁴ beginning in May 2007, although this had stabilised across the USA, Europe, and Japan over the last quarter of 2007 (analysis by Macquarie Research, reported in International Mining online, January 2008). The fall in premiums is likely to have a significant impact on both producers and traders; given the strong increases in freight prices over the previous 12 months, which saw many more than double. In addition, physical metals premiums tend to be strongly correlated with base metals prices, giving a good indication of the physical availability of a metal, correlating here with the dip in production for 2005.

The supply of zinc has been predicted by many to meet, if not exceed, demand over the next few years with new zinc mines being commissioned throughout 2007 and more planned for 2008. At the beginning of 2008 analysts from ABARE, the Australian Government economic research agency, were

⁴ The physical metals premium is the price that metals purchasers are required to pay (freight, insurance, warehousing and logistical costs etc. in addition to the LME price) to receive delivery of their purchase at a specified location.



forecasting continued weakening in the world zinc price as new supplies come on line and stocks recover and production outpaces consumption (Metal Bulletin, 8 January 2008).

Industry events in 2007

The consequences of the record high zinc price have been the rapid development of new mine capacity; new projects, expansions and the reopening of previously sub-economic mines. As a result, there are now a large number of zinc mine projects in the pipeline and the supply of zinc in concentrates is likely continue to rise through 2008. During 2007 the most significant increases in production of zinc concentrates and refined zinc were from Australia, China, Bolivia, Peru, Canada, Portugal and India.

The biggest news for the year was the creation of potentially the world's single biggest zinc producer; a merger of the smelting and alloying assets of Australia's Zinifex Ltd, with Belgium's Umicore Group to create Nyrstar on 31 August 2007. Nyrstar wholly owns operations in Australia (Hobart, Port Pirie), Belgium (Balen, Overpelt), France (Auby, Le Vigeant), the Netherlands (Budel) and the USA (Clarksville). It also has further joint ventures in Australia, China and France and a minority interest in Padaeng Industry Public Company Ltd, Thailand (Nyrstar, 2008).

The merger of EuroZinc Mining and Lundin Mining saw the emergence of another major player on the world zinc market. Lundin Mining Corporation owned four mines, in Portugal, Sweden and Ireland; a fifth, Aljustrel (Portugal) commenced production in December 2007 giving the company a stable base in Europe. With the acquisition of a 49 per cent interest in the Ozernoe project in the Russian Federation (estimated to be the sixth largest undeveloped in the world) from IFC Metropol, Lundin now owns or has an ownership interest in four of the world's fifteen largest zinc deposits, making it a major force in the world market. Lundin like other producers increased both production and investment in 2007, and reported that zinc concentrate production and output at its zinc processing facility at the Neves-Corvo operations in Portugal

reached designated operating levels by 24 January 2007 and that further expansion is planned (Lundin Mining, 2008).

Blessed with a highly prospective geology, Australia remains a world leader in the production of zinc giving it a major influence in the world market. Leading Australian zinc producer Zinifex's, open-pit zinc-lead, Century Mine in Queensland recorded increased zinc concentrate output during 2007 (Giglio, 2007). The Century Mine is also Australia's largest mine and ranked second globally for zinc output. Perilya Ltd is progressing commissioning of their Potosi mine at Broken Hill (Perilya Ltd, 2007). Jabiru Metals Ltd also became Australia's latest zinc producer commissioning the Jaguar zinc-copper project, in Western Australia and making delivery of the first saleable zinc concentrate to Geraldton Port in July 2007. Jaguar is a VMS-style deposit with a grade which is in the top five per cent of VMS deposits worldwide (Jabiru Metals, 2007). Teck Cominco Ltd also restarted production at Lennard Shelf in April 2007 (Giglio, 2007).

China remained a controlling power on the world zinc market and refined zinc production increased throughout 2007, fuelled by both growing international and domestic demand. China now consumes 20 per cent of the world's zinc supply (Hinde and Lovesey, 2007). Driven by high zinc prices investment in zinc mining in China increased during 2005 and 2006. Construction of new zinc mines added some 1.0 million tonnes of mine-production capacity, and in 2006, 0.7 million tonnes of smelting capacity. Despite this, China remains a net importer of zinc concentrate and imports increased by 46 per cent during 2006 (Mining Journal, 18 May 2007). China's Sinosteel Pty Ltd entered into an off-take agreement with Australia's Fox Resources Ltd for all zinc concentrate sales from the West Whundo copper-zinc project. The agreement is for an initial 12 000 tonnes of zinc concentrate (Mining Journal, 11 May 2007). Chinese mining companies also continued to invest overseas, and China's Zijin Mining purchased the Kyzyl-Tashtygskoe lead-zinc mine in Russia, which has lead-zinc reserves of 1.5 million tonnes and an ore grade of about 10 per cent (Metal Bulletin, 20 July 2007). The Chinese Government cancelled the tax refund on exports of refined zinc and on 1 January introduced an export tariff of

five per cent. The tax refund on zinc alloys was also cut from eight to five per cent. A Chinese Government directive that will see the cessation of subsidies to the zinc smelters in the form of reduced electricity prices has also been announced (Metal Bulletin, 22 October 2007). Despite this, there was continued increase in Chinese exports of refined zinc products, fuelled by the expansion in the galvanising sector and by October 2007, causing speculation about further price decreases and a world surplus in 2008 (Meir, 2008).

The year 2007 also saw foreign investment in Chinese mining operations. Currently Griffin Mining has the only new foreign-owned and operated mine and processing plant in China at Caijiaying, which currently produces 500 000 tonnes per year of zinc concentrate with further increases planned for 2008 (Griffin Mining, 2008). In an innovative move, Australia's Penfold Ltd invested as a minority partner in China's Western Mining Co., operator of the country's largest lead and zinc mine. Western's Xitianshan mine has a production capacity of over 1.5 Mt/y of lead/zinc ores, produces 160 000 tonnes per year of metals, and is the biggest independent mine in China (Chadwick and Higgins, 2007). After the separation from its smelting and alloying operations, Zinifex Ltd continues as a major player on the world market in mining. It has now signed a Heads of Agreement with Toronto-listed Asia Now Resources Corp. to form an alliance for mineral exploration in China (Mining Journal, 09 March 2007).

Bolivia saw exports of zinc concentrate rise with the commissioning, in September 2007, of the San Cristobal mine. It is jointly owned by Apex Silver and the Sumitomo Corporation and considered to be one of the world's largest silver-zinc-lead development projects. The first shipment of concentrates [to Asian Smelters] was reported on 18 October 2007 (Apex Silver Mines Ltd, 2007).

Increased output of zinc concentrate from Peru was principally the result of the commissioning of Gold Hawk Resources Inc.'s Coricancha Mine and processing facility, with the first lead and zinc concentrates produced in February 2007 (Gold Hawk Resources, 2007), and Minera Milpo's Cerro Lindo operation in July (Metal Bulletin, 21 July 2007). Fortuna Silver Mines Inc. commenced production of zinc concentrates from Caylloma silver-lead-zinc mine, Peru, in November 2006 (Fortuna Silver Mines Inc, 2006).

In Canada the Acadian Mining Corporation commenced production at Scotia Mine, an open-pit zinc-lead mine at Gays River, Nova Scotia in May 2007. The mine is expected to produce 30 000 tonnes per year of high grade zinc concentrate (Acadian Mining Corp, 2008). Breakwater Resources Ltd's Langlois mine in north-west Quebec also commenced commercial production on 1 July 2007 (Breakwater Resources Ltd, 2007). Further mines are also set to open, and the Yukon Zinc Corp expected to commence production at Wolverine silver-zinc project in 2009 with concentrate being shipped to Asia for processing (Higgins, 2007). Overland Resources Ltd also secured a controlling interest in the Andrew Base Metal Project in January 2007 and is now endeavoring to fast-track the now proven high grade zinc deposit to production (Overland Resources Ltd, 2007).

Despite increased mining and production, the US is increasingly reliant on imported raw and processed zinc, with a net import reliance of 76 per cent in 2006. In the same year, 80 per cent of the US mine output came from a single mine, Red Dog Mine in Alaska, which is operated by the world's second-largest zinc miner, Teck Comnico Ltd. In 2007, US mining saw the reopening of previously sub-economic mines

in Tennessee and New York State (Mining Journal, 13 April 2007).

Global refined zinc metal production is also set to increase in 2008. The largest rises will be in China and India, where Hindustan Zinc Ltd commissioned a second 170 000 tonnes/year hydrometallurgical zinc smelter (Hydro II) at Chanderiya in 2007 (Hindustan Zinc Ltd, 2008)

Finally, with both increasing demands and prices during 2006 and the first half of 2007, the focus on recycling increased. Brass and galvanised steel scrap are the largest contributors to recycling. The Tasmanian Government has granted approval for Sydney-based Intec Hellyer Metals Pty Ltd to build a plant at their Hellyer mill in the town of Burnie to refine zinc from electric arc furnace dust. The company hopes to use the process elsewhere in the near future (RecyclingBizz.com, 2008).

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Mine production of zinc

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Armenia	782	2 065	1 927	3 196	2 270
Bulgaria	12 900	13 000	*12 700	*12 000	*10 400
Finland	34 100	38 800	37 200	40 500	35 700
Greece	35 000	3 000	—	4 000	18 000
Irish Republic	276 700	419 000	438 300	445 400	425 800
Macedonia	2 133	—	—	—	21 672
Poland	152 100	154 277	140 381	135 600	126 600
Portugal	—	—	—	—	7 505
Romania	21 512	22 081	23 599	13 784	9 574
Russia	162 000	159 000	161 700	186 000	178 000
Serbia	—	—	—	—	8 000
Serbia and Montenegro	6 273	5 618	2 000	3 000	—
Spain	69 926	15 140	—	—	—
Sweden	148 620	185 884	197 034	215 691	210 029
Turkey	43 000	40 000	39 000	56 000	62 000
Algeria	4 500	1 450	116	2 206	303
Morocco	90 513	85 200	87 000	128 000	95 000
Namibia	41 042	105 452	185 228	202 168	185 355
South Africa	64 173	41 239	32 001	32 112	34 444
Tunisia	35 692	36 200	29 011	15 713	3 000
Canada	916 220	788 063	791 373	666 664	637 726
Honduras	46 339	43 766	41 413	42 698	37 646
Mexico	446 104	413 991	426 360	476 307	*480 000
USA	780 000	767 600	738 900	747 900	727 100

Mine production of zinc

tonnes (metal content)

Country	2002	2003	2004	2005	2006
Argentina	37 325	29 839	27 220	30 227	29 808
Bolivia	141 708	145 490	147 430	159 502	172 747
Brazil	136 339	152 822	158 962	170 659	185 211
Chile	36 161	33 051	27 635	28 841	36 238
Peru	1 221 616	1 372 790	1 209 006	1 201 671	1 201 794
Burma	*1 600	*1 600	*1 600	*1 600	*1 400
China	1 624 100	2 029 100	2 391 200	2 547 800	2 996 000
India (a)	262 100	318 300	354 600	475 800	510 584
Iran	121 000	111 000	135 000	167 000	164 000
Japan	41 581	47 800	47 800	41 500	7 200
Kazakhstan	392 400	393 200	361 400	364 300	366 100
Korea, Dem. P.R. of	*32 000	*52 000	*62 000	*65 000	*68 000
Korea, Republic of	99	—	14	77	16
Laos	540	1 200	1 000	1 500	*1 500
Mongolia	—	—	—	11 400	50 500
Philippines	—	—	—	2 000	3 000
Saudi Arabia	1 200	900	1 000	1 000	1 000
Thailand	15 188	14 830	19 948	20 381	21 402
Vietnam	44 000	50 000	40 000	48 000	45 000
Australia	1 469 000	1 479 000	1 334 000	1 367 000	1 362 000
World Total	9 000 000	9 600 000	9 700 000	10 100 000	10 500 000

Note(s):-

(a) Years ended 31 March following that stated

Production of slab zinc

tonnes

Country	2002	2003	2004	2005	2006
Belgium	238 700	244 400	272 500	222 000	251 000
Bulgaria	83 000	86 800	101 500	92 500	85 900
Finland	235 300	265 900	284 525	281 904	282 238
France	333 300	257 000	260 000	209 000	210 000
Germany	378 561	388 131	382 020	334 900	342 600
Italy	175 800	123 100	118 400	121 200	109 200
Macedonia	48 599	23 746	—	—	—
Netherlands	203 460	224 000	224 000	227 500	221 500
Norway	144 538	143 627	140 901	148 000	160 670
Poland	158 900	154 200	155 500	137 300	133 900
Romania	38 000	51 000	52 746	56 795	43 705
Russia	257 000	253 000	239 000	211 000	230 000
Serbia	—	—	—	—	*10 000
Serbia and Montenegro	1 478	62	3 664	18 000	—
Spain	503 000	519 000	525 000	501 400	502 800
United Kingdom	99 600	16 600	—	—	—
Algeria	33 900	34 928	33 414	36 699	32 617
Namibia	—	47 436	120 533	132 818	129 897
South Africa	111 000	112 000	105 000	104 000	90 000
Zambia	2 000	2 000	2 000	—	—
Canada	793 410	761 199	805 438	724 035	824 465
Mexico	302 122	320 364	316 834	327 205	279 734
USA	294 400	302 600	306 000	309 000	*309 000
Argentina	41 797	42 360	38 298	40 457	45 991
Brazil	254 700	270 000	273 000	274 000	279 000
Peru	172 688	202 076	195 692	163 603	175 250

Production of slab zinc

tonnes

Country	2002	2003	2004	2005	2006
China	2 155 100	2 318 500	2 719 500	2 776 100	3 153 000
India	248 000	280 000	272 000	302 000	415 000
Iran (a)	81 000	78 428	109 400	140 000	140 000
Japan	639 925	651 246	634 637	638 352	614 331
Kazakhstan	286 454	294 965	316 700	338 000	348 500
Korea, Dem. P.R. of	*34 000	*55 000	*65 000	*57 000	57 000
Korea, Republic of	605 990	644 218	669 171	646 817	667 000
Thailand	104 900	113 700	115 500	104 500	94 779
Uzbekistan	78 900	58 100	*58 000	42 000	46 000
Vietnam	—	—	—	7 000	12 000
Australia	565 000	553 000	473 000	457 000	464 000
World Total	9 700 000	9 900 000	10 400 000	10 200 000	10 800 000

Note(s):-

(a) Years ended 20 March following that stated

Production of zirconium minerals

tonnes

Country	2002	2003	2004	2005	2006
Russia (a)	*6 500	*6 500	*6 500	*6 500	*6 500
Ukraine	*34 300	*35 000	*35 000	*35 000	*37 000
Gambia	...	12 000	*12 000	*12 000	*12 000
South Africa	*420 000	*370 000	379 000	314 000	406 000
USA	132 000	144 000	172 000	164 000	143 000
Brazil (a)	20 000	27 198	25 263	25 657	25 120
China	*20 000	*20 000	*20 000	*20 000	*20 000
India	23 219	25 263	25 432	27 133	*22 000
Indonesia	*250	*250	*200	*200	*200
Malaysia	5 293	3 456	6 686	4 954	1 690
Sri Lanka	—	—	12 826	23 587	8 321
Vietnam (b)	*10 800	*21 300	*40 000	*35 000	*27 000
Australia	413 000	462 000	441 000	426 000	492 000
World Total	1 097 000	1 127 000	1 176 000	1 094 000	1 201 000

Note(s):-

(1) In this table the term 'zirconium minerals' is understood to mean zircon, unless otherwise stated

(a) Including caldasite rock containing zircon and baddeleyite

(b) Conservative BGS estimates, based on exports

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