Index

acid plants see sulphuric acid
acid rain 5, 21–2, 124, 161
see also environmental imperatives;
sulphur dioxide
Africa 2, 15, 161, 162
see also Congo; South Africa;
Tanzania; Zambia; Zimbabwe
AGIP Australia 33
Alcan-alusuisse-Pechiney merger 18
Alcoa-Reynolds merger 18
Alliance Copper 30
Altonorte 8, 58, 59, 60, 64, 69
America Mineral Fields 16, 32
Anaconda Copper Company 45, 47, 49
Andes Copper Mining Company 45, 49, 55
Andina, Compañía Minera 46, 47, 49, 50
Aneka Tambang 16
Anglo American 16, 32, 33, 52, 58, 63, 111, 116, 128
anode production 2, 3, 4
Chile 44, 49, 51, 52, 68
China 85, 91
Peru 113, 115
see also copper; smelting
Antamina 18, 112, 116, 117, 128–9
antimony 27, 106
Argentina 14, 34
arsenic pollution 4, 28, 30, 60, 64, 67, 122, 123, 163
ASARCO 18, 26, 30, 32, 106, 127
Ashanti Gold Fields 17, 30
Ashton 30
Asia 128, 157, 161, 162, 164
see also China; India; Indonesia;
Japan; Philippines; Thailand
Atacama Kozan 18
Atlantic Copper 171
Atlas Copco 149
Aur Resources 29
Ausmelt process 4, 33, 82, 98–9
Australia
China, imports from 90
foreign investment 12, 53
Jameson Cell technology 26–7
political risk insurance 38
sulphur dioxide emissions 161, 162
world copper output, share of 2
BACOX process 29
BacTech 29
bacterial leaching 27, 29, 30
Baiyin process 4, 76, 77, 78, 79, 87, 95, 98
Barrick Gold merger 18
BAT (Best Available Technology) 37, 161
bath smelting 21–2, 65, 95
see also Noranda
Beijing General Research Institute of
Non-ferrous Metals 78, 95
BHP 18, 31, 52, 112, 113, 114, 116
Billiton 18, 29–30, 31, 52, 114, 116
Bingham Canyon 19–20, 23, 126
BioCOP process 30
bioleaching 27–8, 29, 30
BIOX process 29–30
BioZINC 30
bismuth 28, 106
blast furnaces 4, 7, 82
blister copper
Chile 49, 51, 58, 60
China 86, 87, 89, 92–3, 97, 98
direct-to-blisten 25, 166, 168, 169
Peru 113, 115
production of 2, 3, 4, 8, 24, 25, 170
Russia 141, 149, 154
see also smelting
Boart Longyear 149
Boliden 24, 149
Bolivia 15, 31
Braden Copper Company 45, 49
Brazil 16, 30
Bridge, Gavin 11–43

Brundenius, Claes
‘From nationalization to re-privatization of the Peruvian copper industry’ 104–34
‘Introduction’ 1–10
‘Technological change and the environmental imperative in Chile’ 44–72

Budanov, Igor 135–59

Bwana Mkubwa project 32

cadmium 122, 163
Cajamarquilla Zinc Refinery 112
Caletones 58, 59, 60, 61, 62, 63, 65, 66
Calitos Palitos pollution 55
Cambior 36, 128
Cameroon 14
Canada 2, 4, 12, 22, 26–7, 53, 161
Candelaria 18
Casapalca Mine 112
cathode production 2, 3
Chile 47, 48
China 82, 83, 85, 86, 89–91, 92–3, 97–8
see also copper; smelting
Centromín 15, 16, 105, 111, 118, 119, 121–3
Cerro Colorado 18
Cerro de Pasco Corporation (CdeP) 46, 105, 106, 107, 111, 112, 117, 119, 121
Cerro Negro 18
Cerro Verde 18, 111, 112, 114, 116
Charges 58, 59, 63, 69
Chañaral Bay pollution 55–6

Chile
Chileanization 46, 65
CODELCO see CODELCO
environmental imperative 36, 54–68
foreign investment 12, 45, 46, 52–4
joint ventures 46
Mining Integration Treaty 14
nationalization 44, 46–7
privatization 17, 18
taxation on copper production 46
Technological change 44–72, 113
world copper output, share of 2, 3, 44, 45–7

Chile Exploration Company 45

China
decentralization 74
employment considerations 80–81
environmental imperative 76–9, 83, 86–7, 92, 93–4
growth record 73–4
market economic principles 74, 80
non-ferrous metals sector reform 73–6
state-owned enterprises (SOE) 73, 74, 80, 84, 99–101
technological change 73–103
world technological change 73–103
China Copper, Lead and Zinc Corporation (CCLZ) 75, 76
China National Nonferrous Metals Corporation (CNNC) 74, 75, 80–81, 83, 90, 92, 94, 95
Chuqui Sur mine 48
Chuquicamata smelter 25, 45, 48–9, 50, 52, 58, 59, 60–61, 63, 66, 68
CMD (Compañía Minera Disputada de Las Condes) 58, 63
cobalt 29, 32, 33
Cobriza mine 111, 112
Cochilco 68
CODELCO 8, 17, 18, 25, 30, 47–50, 51, 55–6, 57, 58, 60–62, 64–8
Collahuasi 18, 52
COMIBOL 15, 31
Cominco 28, 29, 112
Compantia Siderurgica Nacional 16
Congo 16, 32
continuous smelting see Mitsubishi; Noranda
copper
anodes see anode production
blister see blister copper
cathodes see cathode production
competition 19–21
economic liberalization 11–43
mattes production see matte production
privatization 9, 14–17
smelting see smelting
technological innovation 5, 8, 19–21
technology transfer, opportunities for 33–8
world output 2, 3, 44, 45–7
Copper Cliff 22
Copper Range 5
Cottrell system 106, 119
CRA merger 18
Cuajone 113, 114, 116, 117, 121, 124, 125–6, 127
CVRD (Companhia Vale do Rio Doce) 15–16
Cyprus Climax Minerals 111
Cyprus-Amax 17, 18, 112
Daye smelter 8, 76, 77, 79, 86–9
direct-to-blister process 25, 166, 168, 169
see also Outokumpu flash smelting
Disputada de Las Condes, Compañía Minera 58, 63
Doe Run 26, 105, 111, 112, 114, 115, 116, 121–3, 130
DON process 24, 173
economic liberalization 11–43, 33–4
Ecuador 14
El Abra 17, 18
El Salvador 45, 49, 50, 55, 58, 61
El Teniente see Teniente converter
El Tesoro 18
electrowinning see Sx/Ew
ENAMI 58, 62–3, 67, 68, 69
environmental imperatives
and economic liberalization 11–43
future challenges 160–63
pollution prevention, innovation for 21–5
remediation and reuse 31–3
see also individual countries; innovation; sulphur dioxide
Escondida 18, 48, 52
Euro-Nevada merger 18
European Bank for Reconstruction and Development 38
European Community, sulphur dioxide emissions 161, 162
Exótica 48
Exxon Minerals 58, 63
Falconbridge 52
FDI see foreign direct investment
Finland 53, 148
Outokumpu see Outokumpu
First Quantum Minerals 16, 32
flash smelting
China 78–9, 82, 84, 87, 88
CODELCO smelters 60, 61, 65, 67, 68
future developments 160–74
Russia 149
technology 4, 5, 6–7, 21–5
see also INCO; Noranda;
Outokumpu
foreign direct investment (FDI) 9,
11–12, 13–14, 31, 34, 35–6, 45, 52–4, 69
see also individual countries
France 15, 90
Franco-Nevada 18
furnaces
blast 4, 7, 82
flash see flash smelting
reverberatory see reverberatory furnaces
see also copper; smelting
Furukawa Corporation 24, 130, 160, 165
Gaisky GOK 144, 154
Gecamines 16, 32
Gencor 18, 29–30
Ghana 15, 17
Girilambone 28
Glencore International 16
Glogow 25
gold 7, 15, 17–18, 28, 29–30, 36, 82, 86, 90, 92, 105
Gold Fields 30
Golden Star 36
Göransson, Bo 73–103
greenfield investment 13, 21, 65, 99, 165, 167, 169, 171
Grupo Mexico 18, 24, 127
Guinea 15
Guixi smelter 76, 77, 79, 90–92
Guyana 36
Haldor Topse 149
Hanniala, Pekka 160–74
heavy metals 54, 119, 161
Hierro Peru 111, 112
Hindustan Copper 16
HSBC 17
Huludao smelter 77
hydrometallurgy, innovation in 27–31
  see also Sx/Ew

IFC (International Finance Corporation) 32, 38, 52
Ilo smelter 18, 24, 107
copper production 114, 115
environmental concerns 117, 120–21, 127–8
modernization 24, 113, 123–4, 125, 126
nationalization in Peru 108
privatization 111, 112
INCO flash smelting 4, 6, 8, 22, 24, 65
India 16, 172
Indonesia 2, 16
innovation
  and economic liberalization 11–43
  in hydrometallurgy 27–31
  for pollution prevention 21–5
  for remediation and reuse 31–3
  smelter feedstocks 32–3
International Convention on Trans-Border Pollution 148
Interross group 151
iron 14, 15, 106, 111
ISASMELT process 32, 94
Italy 26–7, 90
Itochu 94
Itos tailings 31
Ivan-Zar 28

Jackling, Daniel 19
Jameson Cell technology 26–7
Japan
  China, soft loan to 81, 84
flash converting technology 172
foreign investment 11, 53
sulphur dioxide emissions 161, 162
world copper output, share of 2, 3, 44
Japan Energy 52
Japanese Overseas Economic Cooperation Fund 38
Jiangxi Copper Company 90, 92
Jinlong smelter 94
Junin, Lake of 119

Karabash 140–41, 149
Kennecott Corporation 45–6, 47, 49, 65
Kennecott-Outokumpo flash converter
  6, 8, 23–5, 61, 62, 126, 127, 166, 169, 173
KGHM 16
Kirovograd Copper Company 150, 154–5
Kojo, Ilkka V. 160–74
Kokpatas Mine 30
Kolsky Mining and Metal Company 150
Kolwezi project 16, 32
Konkola mines 16
Krasnouralsk MSK 144
Krasnoyarsky 150
Kuznetsov, Boris 135–59
Kyshtym 149
La Aquire 28
La Granja 18, 111, 112, 116, 128
La Oroya 105–6, 111, 113, 114, 115, 117, 119, 121, 122, 130
Lac Minerals merger 18
Laizhou 29
lance technology see Ausmelt process
Las Pelambras 17, 18
Latin America 12, 15–16, 36
  see also Argentina; Bolivia; Brazil; Ecuador; El Salvador; Mexico; Nicaragua; Peru
leaching, bacterial 7, 20, 27–8, 29, 30, 51, 54, 127, 161, 162
lead
  as a by-product 7, 24, 82, 84, 105, 106
  ISASMELT process 32–3
  and pollution 119, 122, 141, 143, 163
legislative frameworks 36–8
liberalization of investment regimes 11–43
Linde 149
Lucumba 117, 120

Magma Copper Company 18, 112
Mahn Tunel Mine 112
Mansa Mina 30
Mantos Blancos 18, 111, 112
Marcona Mining Company 106, 111
Marubeni 112
matte
- high-grade, with concentrate 61, 79, 168
- importing 62, 169–70, 172
- production 4, 7, 23, 25, 58

Mejillones 61
mercury 163
mergers 17–18
Metal Oroya see La Oroya
Mexico 2, 16, 29, 67
Midland Bank 17
MIM (Mount Isa Mines) 26–7
Mina Sur 49
Minero Peru 16, 107–8, 109, 110, 111–13
Mintek 29
Mitsubishi 4, 6, 8, 52, 127, 129
Mitsui 52, 130
Mopani Copper Mines 16
MTC see Teniente
multinational enterprises (MNCs) 34, 36
Nadezhda 152, 153
National Environmental Protection Agency of China (NEPA) 77
Navoi Mining and Metallurgy Combinat 30
Newmont Mining 18, 106
Nicaragua 15
nickel
- Ausmelt process 33
- flash smelting 22, 24
- leaching 28, 29
- and pollution 136, 142, 143, 144 see also Norilsk Nickel
Noranda 4, 6, 8
- bath smelting 65, 82
- in China 82, 83–4, 86, 88
- Collahuasi mine 18, 52
- in Peru 112, 116, 128
- Refinit smelter 58, 64
- and sulphur dioxide emissions 22
Norilsk Nickel 140, 147, 148, 149, 150–54
Norimet 150
Normandy Mining merger 18
North and Ashton Mining merger 18
Norway 148

Olympic Dam 25
Omai gold mine 36
Onsan 172
open pit mining 18, 19–20, 32, 45, 48, 49, 51
Outokumpu flash smelting 4, 6, 7, 17
- Chile 60, 61, 63, 64, 65
- China 82, 90, 94, 95
- future challenges 162, 165, 166, 168, 171, 172, 173, 174
- Peru 122, 126, 127, 129
- Russia 149, 153, 155
see also Kennecott-Outokumpo flash converter
Paipote 58, 59, 62–3
Pampa Austral tailings dam 55
Paragsha Mine 112
PASAR (Philippine Associated Smelter and Refining Corporation) 16, 17, 172
Pechenganickel 150, 152
Peirce-Smith converter 4, 6, 23–4, 25, 171, 172
- Chile 58, 62, 64, 65–6
- Peru 123–4, 126, 127
Peko Mines 26
Peñoles Industries 29, 111
Peru
- environmental imperative 117–23, 128–9
- foreign investment 106–7, 109–10, 128–9, 130
- General Mining Law 107–10, 118
- Minero Peru 16, 107–8, 109, 110, 111–13
- Mining Code 106–7, 108
- mining projects, new mega 128–9
- Modernization Plans 124–6
- nationalization 104–34
- reprivatization 15, 16, 18, 105, 110–13, 118, 130
- SOE (state-owned enterprises) 109–10, 111, 114, 115, 116, 118
- SPCC see Southern Peru Copper Corporation
- structural changes in copper industry 104–34
- technological change 126–8
Peru (continued)
  world copper output, share of 2, 3, 104
Phelps Dodge 18, 106, 111, 112, 114, 116, 127
Philippines 16, 17
platinum 150
Poland 2, 16, 25
pollution control see environmental imperatives
Pollution Prevention and Abatement Handbook 162, 163
porphyry revolution 20
Portugal 15
Potrerillos 45, 49, 55, 58, 59, 60, 61–2, 63, 66
privatization 14–17, 33, 34
privatization of state mining firms, see also individual countries
process control, innovation in 12, 25–7
Pudahuel, Minera Sociedad 28–9
pyrometallurgy 4–5, 24, 28, 33, 45
see also flash smelting
Quebrada Blanca 18, 28
Quellaveco 18, 111, 112, 116, 128
Radomiro Tomic Division 49, 50
Refrmit 58, 64
remediation and reuse, innovation for 31–3
Renco Group 111
Resource Conservation and Recovery Act 32
reverberatory furnaces 4, 5–6, 7, 22
  Chile 58–9, 60, 64, 66, 67
  China 82, 86, 95
  Peru 123–4
replacement of 161, 165, 167, 171
Russia 149, 153, 154
Rio Algom 18, 112, 128
Rio Blanca 46, 49
Rio summit 117
Rio Tinto 18, 33, 52
Royal Dutch Shell Group merger 18
RTZ merger 18
Russia
economic crisis 147, 148, 151, 157
environmental imperatives 136, 137–46, 153–5, 156
legislation 149–50, 156
non-ferrous metals 136, 142–6, 157
privatization 136, 146, 151, 157
technological change 4, 135–59, 149, 153–5, 156–7
world copper output, share of 2, 3
Salvador Division 45, 49, 50, 55, 58, 61
selenium 90
Severonickel 144, 152
Shanghai smelter 77, 79
Sharpline 94
Shenyang 8, 76, 77, 79, 80–81, 82–5, 86, 87–8
Shougang Corporation 111, 112
silver 7, 31, 90, 92, 104, 105
slag waste 4, 7–8, 33, 55, 63, 67, 87, 125, 152, 166
see also tailings retreatment
smelting
  anodes see anode production
  bath 21–2, 65, 95
  blister copper see blister copper
  continuous see Mitsubishi; Noranda
  feedstocks 32–3
  flash see flash smelting
  future scenarios 168–72
  investments 165–8
  operational challenges 163–5
  oxygen 4, 5, 65, 66, 79, 88
  and pollution control 3–5, 21–5, 54, 55, 58–64
  process control 25–7
see also Sx/Ew
SO2 see sulphur dioxide
solvent-extraction/electrowinning
  processes (Sx/Ew) see Sx/Ew
South Africa, and foreign investment 12, 53
South African Industrial Development Corporation 32
South America see Latin America
Southern Peru Copper Corporation (SPCC)
copper production 113, 114, 116, 117
environmental concerns 120–21
investment in 106–7
modernization 24, 123–8
and privatization 110, 112, 130
Southwest Research and Information Center (SRIC) 123
Soviet Union 138–40
see also Russia
State Nonferrous Metals Industry Bureau (SNB), China 74–5
sulphur dioxide emissions and acid rain 21–2
and BIOX process 30
capture improvements 7–8, 161, 163, 171
Chile 54–7, 58–9, 60, 61–2, 63, 64, 65, 66, 67, 68
China 78, 79, 82, 83, 84, 86–7, 89, 94, 95, 99
Peru 119, 120, 121–2, 123, 124–5, 126
pollution problems 4–6, 23–4, 44
Russia 148, 151, 152
sulphuric acid
Chile 58–9, 60, 61–2, 63, 64, 65, 66, 67, 68
China 79, 84–6, 88–9, 90, 92, 93, 94, 96–9
for leaching 20
Peru 119, 121–2, 123, 124–5, 126, 127
production of 5, 7, 8, 22, 160–61, 170
Russia 152
Sumitomo 83, 90, 94, 95
Superfund waste disposal 32, 37
Sweden 24, 148
Sx/Ew (solvent-extraction/electrowinning processes) 3, 4–5, 20, 27–30, 164
Chile 45, 47, 49, 52
Peru 113, 114, 125, 127
Russia 152
tailings 26, 27, 28, 31–3, 54, 55–6, 124
Tambo 30, 117, 120
Tamrock 149
Tanzania 15
technological innovation in copper industry 5, 8, 19–21
technology transfer, opportunities for 33–8
Teck 28, 29, 112, 128
tellerium 90
Teniente converter 4, 6, 25
Chile 60, 61, 62, 63, 65–7
Peru 127, 130
Teniente mine 45, 46, 49, 50, 58
Thailand 67
thermophilic bacteria 29, 30
*Thiobacillus ferrooxidans* bacteria 27
Tintaya 18, 112, 113, 114, 116
TMC see Teniente converter
Tolnakh 151
Toquepala 107, 113, 114, 116, 117, 124, 125, 127
turbulent bath smelting 21–2, 65, 95
Uchaninsky GOK 144
Udakan 158
Uneximbank 151
United Kingdom 11, 15, 53
United States
air quality regulations 5, 20, 54
Chilean copper import suspension 56–7
environmental imperatives 5, 36–7, 56
foreign investment 11, 12, 53
sulphur dioxide recovery 59, 126, 161–2
waste disposal 32
world copper output, share of 2, 3, 44
Ural Mining and Metal Company 148
Uralelektromed 154
uranium 28
USSR see Russia
Uzbekistan 30
Vaitsos 34
Valepar 16
Vanyukov process 4, 149, 152, 153
Ventanas 58, 59, 62–3
Volcan Minera 112
Warhurst, Alyson 11–43
waste reduction 4, 12, 31, 32–3
see also slag waste; tailings
water pollution 143
World Bank 14, 38, 83, 162–3
world copper output 2, 3, 44, 45–7
World Trade Organization 75
<table>
<thead>
<tr>
<th>Location/Company</th>
<th>Page Numbers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Youanmi</td>
<td>29</td>
</tr>
<tr>
<td>Yunnan smelter</td>
<td>76, 77</td>
</tr>
<tr>
<td>Yuracmayo</td>
<td>112</td>
</tr>
<tr>
<td>Zaire</td>
<td>16</td>
</tr>
<tr>
<td>Zaldivar</td>
<td>18</td>
</tr>
<tr>
<td>Zambia</td>
<td>15, 16, 32, 67</td>
</tr>
<tr>
<td>ZCCM (Zambia’s Consolidated Copper Mines)</td>
<td>15, 16</td>
</tr>
<tr>
<td>Zhong Tiao Shan smelter</td>
<td>76, 78, 79, 98-9</td>
</tr>
<tr>
<td>Zhu Zhou zinc smelter</td>
<td>74</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>33</td>
</tr>
<tr>
<td>Zinc</td>
<td>7, 21, 26, 27, 28, 30</td>
</tr>
<tr>
<td>China</td>
<td>74, 75, 82, 84</td>
</tr>
<tr>
<td>Peru</td>
<td>105, 106, 112, 128</td>
</tr>
<tr>
<td>ZTS smelter</td>
<td>98, 99</td>
</tr>
</tbody>
</table>