Life beyond ferrochrome

A review of chromite ore supply
plus a focus on special grades

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Industrial Minerals Information Ltd

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ICDA Paris Meeting
12-13 November 1998

- Last week: absorbent clays for cat litter
- Next week: fused silica for semiconductors
- This week: Chromite
Life beyond ferrochrome

1. Overview of chromite ore supply

2. Focus on special grades
World chromite reserves distribution
482m. tonnes Cr

South Africa 61%
Kazakhstan 21%
Zimbabwe 9%
India 4%
Finland 2%
Others 3%

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World chromite deposits - stratiform

- South Africa: 79%
- Zimbabwe: 12%
- India: 5%
- Finland: 3%
- Others: 1%

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World chromite deposits - podiform

Kazakhstan 91%

Turkey 2%

Philippines 2%

Albania 2%

Others 3%
Chromite ore: the route from mine to market

- Mine
  - Processing
    - Lumps/chips
      - FeCr
        - Steelmaking
    - Fines
      - Concentration
        - FeCr
          - Special grades
            - Chemical
              - Foundry
              - Refractory
            - Steelmaking
Trends & developments in chromite ore supply

- Cyclical & follows FeCr supply and demand
- Special grades demand has minimal impact
- SA dominant
- SA output rise, FeCr integration, ownership changes
- Problems in Kazakhstan & Albania
- Trade mainly to Europe & Asia
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Trends & developments in 

chromite ore supply

• Cyclical & follows FeCr supply and demand
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Production of chromite
1990-97 (m. tonnes)
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Chromite ore demand
1997 12.8m. tonnes

FeCr 73%
Chemical 8%
Foundry 5%
Refractory 2%

FeCr traded 12%

Source: FAH Marketing
FeCr the driving force
Chromite & ferrochrome production
1990-97 (m. tonnes)
FeCr outlook

Stainless steel demand
4-5% growth to 2010

FeCr production capacity rise
4m. to 7m. tpa by 2010

Increased demand for chromite ore

Chromite ore production capacity rise
11m. to 21m. tpa met. Cr
Trends & developments in chromite ore supply

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Chromite ore production
14.1 m. tonnes 1997

- South Africa: 47%
- Kazakhstan: 15%
- Turkey: 11%
- India: 10%
- Others: 17%
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Leading chromite producers 1997

<table>
<thead>
<tr>
<th>Country</th>
<th>Production (m. tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>6.672</td>
</tr>
<tr>
<td>Kazakhstan</td>
<td>2.076</td>
</tr>
<tr>
<td>India</td>
<td>1.363</td>
</tr>
<tr>
<td>Turkey</td>
<td>1.593</td>
</tr>
<tr>
<td>Zimbabwe</td>
<td>0.640</td>
</tr>
<tr>
<td>Finland</td>
<td>0.588</td>
</tr>
<tr>
<td>Brazil</td>
<td>0.285</td>
</tr>
<tr>
<td>Iran</td>
<td>0.168</td>
</tr>
<tr>
<td>Albania</td>
<td>0.158</td>
</tr>
<tr>
<td>Madagascar</td>
<td>0.139</td>
</tr>
</tbody>
</table>
Trends & developments in chromite ore supply

• Cyclical & follows FeCr supply and demand
• Special grades demand has minimal impact
• SA dominant
• SA output rise, FeCr integration, ownership changes
• Problems in Kazakhstan & Albania
• Trade mainly to Europe & Asia
South Africa - integration, expansion, corporate change

- world dominance; 55% FeCr production
- Cr ore capacity & output increase
- dominance of “big two” - Samancor
  - Südelektra
  (CR/ CMI )
- 8 major players; “fly by night” operators?
- FeCr integration: 80% Cr ore production
- increased use of fines in FeCr production
- Chrome Chemicals exception
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Trends & developments in chromite ore supply

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• Trade mainly to Europe & Asia
Kazakhstan/Albania

- Kazakhstan
  - KMRC vs TWG dispute smoulders on
  - little or no impact on output

- Albania
  - industry struggling
  - UK/Italian consortium
Trends & developments in chromite ore supply

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- SA output rise, FeCr integration, ownership changes
- Problems in Kazakhstan & Albania
- Trade mainly to Europe & Asia
Traded chromite ore consumption
3.2m. tonnes 1997

FeCr 55%
Chemical 19%
Foundry 16%
Refractory 10%

Source: FAH Marketing
### Chromite trade to Europe 1997 (tonnes)

<table>
<thead>
<tr>
<th>Western Europe</th>
<th>Eastern Europe</th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td>Kazakhstan</td>
</tr>
<tr>
<td>503,537</td>
<td>510,987</td>
</tr>
<tr>
<td>Turkey</td>
<td>Turkey</td>
</tr>
<tr>
<td>63,732</td>
<td>164,753</td>
</tr>
<tr>
<td>Philippines</td>
<td>Albania</td>
</tr>
<tr>
<td>13,833</td>
<td>44,450</td>
</tr>
<tr>
<td>Albania</td>
<td>South Africa</td>
</tr>
<tr>
<td>6,480</td>
<td>13,324</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>Total</strong></td>
</tr>
<tr>
<td><strong>1,277,370</strong></td>
<td><strong>778,272</strong></td>
</tr>
</tbody>
</table>
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**Chromite trade to Asia & Americas 1997 (tonnes)**

<table>
<thead>
<tr>
<th></th>
<th><strong>Asia</strong></th>
<th></th>
<th><strong>Americas</strong></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>South Africa</td>
<td><strong>523,635</strong></td>
<td>South Africa</td>
<td><strong>359,578</strong></td>
<td></td>
</tr>
<tr>
<td>India</td>
<td><strong>476,951</strong></td>
<td>Philippines</td>
<td><strong>24,656</strong></td>
<td></td>
</tr>
<tr>
<td>Iran</td>
<td><strong>164,579</strong></td>
<td>Total</td>
<td><strong>398,291</strong></td>
<td></td>
</tr>
<tr>
<td>Turkey</td>
<td><strong>83,693</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pakistan</td>
<td><strong>51,189</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Philippines</td>
<td><strong>47,435</strong></td>
<td>Total Asia</td>
<td><strong>1,491,667</strong></td>
<td></td>
</tr>
</tbody>
</table>

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Special grades focus

- Chemical
- Foundry
- Refractory
Chromite ore demand
1997 12.8m. tonnes

FeCr 73%

FeCr traded 12%

Chemical 8%

Foundry 5%

Refractory 2%

Source: FAH Marketing
Special grades focus - chemical

- sodium dichromate & various Cr chemicals
- plating, pigments, leather tanning, timber preservation
- Cr:Fe not priority, low often preferred
- 40-45% Cr₂O₃
- friable ore, low SiO₂ (1%), MgO (9-11.5%)
Special grades focus - foundry

- specialist sand in metal casting
- manganese, carbon, alloy steels
- low thermal expansion coefficient, superior heat conducting properties
- angular grain shape, strict PSD, AFS 45-55
- min. 44% $\text{Cr}_2\text{O}_3$, max. 26% $\text{Fe}_2\text{O}_3$, <1.0% silica
- low acid demand
Special grades focus - refractory

- historically used in MgO-Cr$_2$O$_3$ refractory bricks in steel, cement, glass, non-ferrous metals
- co-sintered and fused MgO-Cr$_2$O$_3$
- excellent refractoriness, spalling resistance, good mechanical strength at high temperatures
- Cr$_2$O$_3$ + Al$_2$O$_3$ = >57% refractory grade, <1.0-3% SiO$_2$
- coarse grain size, AFS 30-40
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**Special grades focus**

**supply trends**

*Western world production*

Chemical 850,000 tonnes  
Refractory 400,000  
Foundry 250,000  

_____Total 1,500,000

*World production*

Total +/- 2m. tonnes
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Special grades focus
supply trends

Major producers
South Africa
Philippines
India
Kazakhstan
Turkey
Pakistan
UAE
Oman
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Special grades focus
supply trends

*Major producers*
South Africa
- 1.1-1.4m. tpa
- 55-60% exports
- low Cr:Fe
- greater use of fines
- integrated FeCr
## Special grades focus - supply trends

**South African non-met. prod. cap. estimates**

<table>
<thead>
<tr>
<th>Company</th>
<th>Capacity (tonnes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Buffelsfontein Chrome</td>
<td>18,000</td>
</tr>
<tr>
<td>Chrome Chemicals</td>
<td>300,000</td>
</tr>
<tr>
<td>Chrome Resources</td>
<td>60,000</td>
</tr>
<tr>
<td>CMI</td>
<td>100,000</td>
</tr>
<tr>
<td></td>
<td>(225,000 98/99?)</td>
</tr>
<tr>
<td>Dilokong Chrome</td>
<td>68,000</td>
</tr>
<tr>
<td>Hernic</td>
<td>100,000</td>
</tr>
<tr>
<td>Marico-Chrome</td>
<td>10,000</td>
</tr>
<tr>
<td>Samancor</td>
<td>510,000</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>1,166,000</strong></td>
</tr>
<tr>
<td></td>
<td><em>1,400,000 98/99?</em></td>
</tr>
</tbody>
</table>
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Special grades focus - supply trends

**Major producers**
- South Africa - 55% exports
- Philippines - sharp decline
- India, Iran - mainly domestic
- Kazakhstan - mainly CIS
- Turkey - limited volumes
- Pakistan - grades
- UAE - of refractory
- Oman - grades
- Finland - ceased foundry grade
FeCr outlook

Stainless steel demand
4-5% growth to 2010

FeCr production capacity rise
4m. to 7m. tpa by 2010

Increased demand for chromite ore

Chromite ore production capacity rise
11m. to 21m. tpa met. Cr

Increased “availability” of special grades?
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Special grades focus
markets trends
Non-met. market 1.8-2m. tonnes

- Chemical: 55%
- Foundry: 20%
- Refractory: 5%
- Others: 14%

33%
Transvaal chromite ore prices 1995-98
US$/tonne

Source: Mineral PriceWatch; Metal Bulletin
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Special grades focus
markets trends
Current prices

Transvaal, wet bulk, FOB US$/tonne

<table>
<thead>
<tr>
<th>Grade</th>
<th>Price Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical</td>
<td>75-85</td>
</tr>
<tr>
<td>Foundry</td>
<td>82-92</td>
</tr>
<tr>
<td>Refractory</td>
<td>100-120</td>
</tr>
<tr>
<td>Metallurgical</td>
<td>63-68</td>
</tr>
</tbody>
</table>

Source: Mineral PriceWatch
Special grades focus
markets trends

- Overall market - shrunk from 5m. 1990 to 2m. tonnes in 1998
- Chemical - growth of 1-2%
  - Bayer shifts to SA
- Foundry - stable
- Refractory - declining
  - Cr⁺⁶ hazard
  - niche applications
Conclusions

• SA is the primary supplier of chromite for all grades

• smaller players serve low volume special grade market niches

• special grade markets exert little or no impact on chromite production

• FeCr demand rise = SA Cr ore production rise = “potential capacity” rise for special grades

• met. Cr demand effect on special grade demand/prices

• special grade market growth limited
Life beyond ferrochrome?

A. Nice work if you can get it

B. There is life, but perhaps not as lively as we would wish it!